UNIVERSITY
OF MICHIGAN
JAN 31 1958
PERIODICAL
READING ROOM

DESK

NATURE

A Weekly Journal of Science

Vol. 181, No. 4603 SATURDAY, JANUARY 18, 1958 2s. 6d.

C. Baker
OF HOLBORN LTD. EST 1765

APLANATIC MAGNIFIERS

Cemented triplet lenses yielding well corrected images and flat fields of view. In single pocket mounts, ×8, ×10, ×15. In double mount, ×10 and ×15.

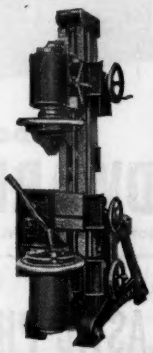
Particulars on request:

C. BAKER OF HOLBORN LTD., METRON WORKS
PURLEY WAY, CROYDON, SURREY (CROydon 3845-6-7)
Showrooms: 244 High Holborn, London, W.C.1

Heathway Glass Working Lathes

are known throughout the world

- 5 types available.
- May we send you leaflets?



Universal Type Mounted Vertically

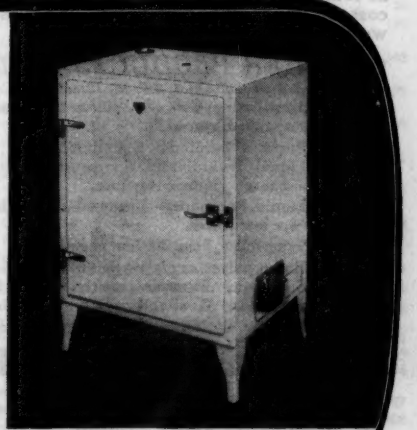
HEATHWAY MACHINERY CO. LTD.
UXBRIDGE ROAD, HILLINGDON, MIDDLESEX
TELEPHONE: UXBRIDGE 6345

B.T.L. Incubators

Used in laboratories engaged in routine or research work all over the world.

- B.T.L. 'Bara' Standard incubators, capsule operated, for temperatures up to 60°C.
- B.T.L. 'Bara' Universal incubators, operated by B.T.L. wide range regulator, for temperatures up to 80°C.
- Various sizes are available for prompt delivery.

Full particulars on request



BAIRD & TATLOCK
(LONDON) LIMITED
CHADWELL HEATH · ESSEX · ENGLAND
LONDON · MANCHESTER · GLASGOW
BRANCHES AND AGENTS ALL OVER THE WORLD

Production Vacuum Furnace *— in miniature!*

. . Pure Melting of Refractory Metals and Alloys

. . High Vacuum Brazing

. . Accurate 'Gas-sampling'

These laboratory vacuum furnaces are the biggest thing in metallurgical research — all metallurgical processes including melting, casting, vacuum brazing and annealing

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

PLASTIC PHOSPHOR NE 102

Our new plastic scintillator possesses extremely high light output (60/65% anthracene) and combines superior performance with greatest economy. Available from stock in any shape up to 400 lb. mass or in thin sheets for alpha and beta ray counting or in rods up to 24 in. diameter. Rough ingot form at considerably reduced cost. NE 102 is the lowest cost plastic phosphor ever offered. For fuller details write for Bulletin 11.

OTHER PRODUCTS & SERVICES

(described in Bulletins 9, 9A, 10, 12 and 13)

- Scintillating Gels, for efficient internal counting of suspended materials.
- Boron, Cadmium, Gadolinium and Lead Loaded Liquid Scintillators for neutron detection, or for enhanced gamma response.
- Liquid Phosphors—Encapsulated, or in bulk form at new low prices.
- Super-pure Scintillation chemicals.
- Boron polyester plastic Scintillator NE400 for neutron detection. Extreme sensitivity even in high gamma ray fields. Available with enriched Boron.
- Nuclear equipment built to your specifications.

NUCLEAR ENTERPRISES (G.B.) LIMITED

Bankhead Medway, Sighthill, Edinburgh, Scotland

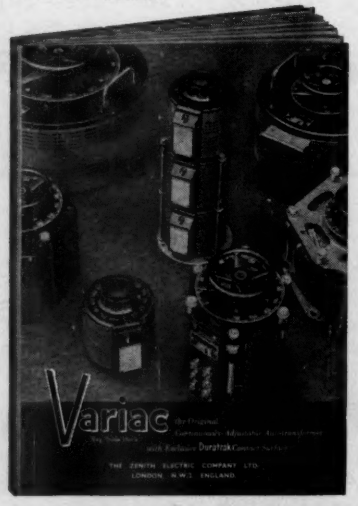
Telephone: CRAiglockhart 4513. Cables: NUCLEAR

Associate Company:

Nuclear Enterprises Ltd., 1750 Pembina Highway, Winnipeg, Canada

* ZENITH New and Improved *"VARIACS" at REDUCED PRICES!

* REGD. TRADE-MARKS



Due to increased demand, up-to-date design practice and modern production methods, we are able to announce substantial *price reductions* on most "VARIAC" models.

A new comprehensive catalogue covering over 170 models is now available and will gladly be forwarded on request.

Most "VARIACS" have the exclusive DURA-TRAK brush track which gives longer life, increased overload capacity and maximum economy in maintenance.

The ZENITH ELECTRIC CO. Ltd.

Zenith Works, Villiers Road, Willesden Green, London, N.W.2.

Phone: WILlesden 6581/5 *Grams:* Voltaohm, Norphone, London

NATURE

No. 4603 SATURDAY, JANUARY 18, 1958 Vol. 181

CONTENTS

Page

Problems of Government in the Modern World 141

A Synthesis of General Embryology. By Prof. J. Brachet 144
Agriculture in East and West. By Sir John Russell, F.R.S. 144
The Chemistry and Biochemistry of the Reductones. By Prof. E. L. Hirst, F.R.S. 145
Physiological Optics. By Prof. W. D. Wright 146

Dr. Irving Langmuir's Contributions to Physics. By Dr. Albert W. Hull 148
The Geological Society of London. By Dr. W. Campbell Smith, C.B.E. 149
Nutritive Value of Proteins. By Dr. D. P. Cuthbertson, C.B.E. 151
Retinal Summation and Human Visual Thresholds. By Dr. R. A. Weale 154

Obituaries :

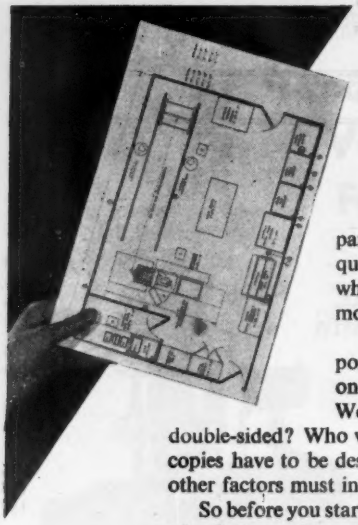
Dr. O. G. S. Crawford, C.B.E., F.B.A. By Dr. J. K. S. St. Joseph 156
Prof. W. J. Jongmans. By Alan Wesley 157
Mr. C. T. Gimingham, O.B.E. By F. H. Jacob 157

News and Views 158

A Wages Policy. By T. H. Hawkins 162
The Home Universities Conference 164
Automatic Measurement of Quality in Process Plants 165
Science in United States Universities 167
Starling Roosts 167
The National Trust 167
Growth and Reproduction in Worm-free Sheep at Pasture. By Dr. C. R. W. Spedding, T. H. Brown and I. A. N. Wilson 168
Localized Electrons in Body-centred Cubic Metals. By J. S. Griffith and L. E. Orgel 170
Origin of Tektites. By John A. O'Keefe ; Carlos M. Varsavsky ; Prof. T. Gold 172
A Possible Basis for Phyto-Immunity. By D. H. Taysum 174

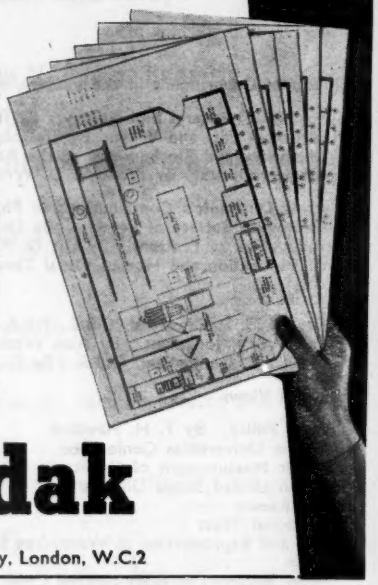
Letters to the Editors :

Electron Spin Resonance of Coals : Saturation Effect.—J. Smidt . 176
Dispersion Energies in Porous Sorbents.—Prof. R. M. Barrer, F.R.S. 176
Flame Ionization Detector for Gas Chromatography.—J. Harley, W. Nel and Dr. V. Pretorius 177
Electric Double Hysteresis in $(K_xNa_{1-x})NbO_3$ Single Crystals.—L. E. Cross 178
Germanium and Gallium in Sea-Water.—J. D. Burton and Dr. J. P. Riley ; F. Culkin and Dr. J. P. Riley 179
'Sub-Grains' and Etch Figures in Lead.—E. J. Hooker . . . 180
Anomalous Atmospheric Refraction at Sea.—Dr. B. M. Cwilong . 181
Effect of the Metallic Ion on the Infra-Red Spectra of Salts of Carboxylic Acids.—Bryan Ellis and H. Pyszora 181
A New Class of Antibiotic Salts of Reduced Toxicity.—F. A. Alves, M. F. C. A. N. Graca and H. L. Baptista 182
A New Series of Anthelmintics.—F. C. Copp, O. D. Standen, J. Scarnell, Deirdre A. Rawes and R. B. Burrows 183
The IX-α Structure of the Common Bile Pigments.—Prof. C. H. Gray, Dr. D. C. Nicholson and R. A. Nicolaus 183
A Ribonucleoprotein from Amphibian Gastrulæ.—A. S. G. Curtis 185
β-Glucuronidase, Lipase and Esterase in the Testis of the Cryptorchid Rat.—Dr. Masando Hayashi, Kazuhiro Ogata, Takuro Shiraogawa and Osamu Kawase 186
Inhibition of 5-Hydroxytryptophan Decarboxylase by Phenylalanine Metabolites.—Dr. A. N. Davison and Dr. M. Sandler . . 186
Role of Ferrous Iron in Enzymatic Transamination.—M. V. Patwardhan 187
Effect of Testosterone and Orchidectomy on the Activity of the Melanocytes in the Skin.—P. G. Bischitz and Dr. R. S. Snell . 187
Effect of some Nitrogen Mustard Derivatives on Growth of Rabbit's Hair.—William J. P. Neish 188
Effects of Gibberellic Acid on Soil Micro-organisms.—Dr. K. C. Lu, C. M. Gilmour, A. C. Zagallo and W. B. Bollen 189
Enzymes in the Ileal Juice of the Horse.—Dr. F. Alexander and A. K. Chowdhury 190
Effect of Electrolytes on the Uptake by Bacteria of Labelled Glutamate.—Y. Avi-Dor and Sh. Miller 190
Novel Action of Potassium on a Yeast and a Counteraction by Aluminium.—Dr. E. J. Miller 191
Detection of Uric Acid in the Tissue Homogenates of Earthworms.—Dr. Gaber M. Haggag and Dr. A. Khalaf El-Duweini . . 191
Electrical Noise from 'Polarization Cells' and from Human Tissues.—A. Nightingale 192
Nervous Control of Cilia in Amphioxus (*Branchiostoma*).—Quentin Bone 193
Neurosecretory Cells in some Cirripedes.—H. Barnes and J. J. Gonor 194
Connective-Tissue Pigment of the Centipede, *Lithobius forficatus* (L.).—Dr. A. E. Needham 194
A Two-stage Transfer of Pathogenicity between the *MEL* and *NWS* Strains of Influenza A Virus.—K. B. Fraser 195
Gestational Changes in Connective Tissue in the Ewe.—Dr. E. G. Bassett 196
Hæmoglobins in Monkeys.—G. F. Jacob and Dr. N. C. Tappen . 197
Hormonal Regulation of Reproduction in the Milkweed Bug, *Oncopeltus fasciatus* (Dallas).—A. S. Johansson . . . 198
Laboratory Variations in Mortality of the Mosquito, *Culex fatigans* Wied., exposed to DDT.—T. Koshi and S. K. Ranganathan . 199
Reversibility of the Red–Far-red Reaction by Irradiation at Different Sites.—Shimon Klein and Dr. John W. Preiss . . 200
Effect of Transmitted Ribonucleic Acid from Healthy Pear Trees upon the Synthesis and Composition of Protein.—Dr. B. Kessler 201
Planting Distance and Number of Seedlings in Rice Cultivation.—N. K. Jain 202
Apparent Requirement for Vitamin K of Rumen Strains of *Fusiformis nigrescens*.—Dr. M. Lev 203
Importance of Photoperiod and Temperature in inducing Diapause in the European Corn Borer, *Pyrausta nubilalis* (Hbn.).—J. A. Mutchmor and Dr. W. E. Beckel 204
Blackhead Toppling Disease of Bananas.—Dr. R. Leach . . 204
Leucocytozoon spp. in some Hertfordshire Birds.—Dr. J. R. Baker 205
Influence of Parasitization on Form Determination in Aphids.—Dr. Bruce Johnson 205
Balanus tulipiformis Ellis on the Atlantic Coast of France and an Unusual Situation for *B. amphitrite* Darwin.—B. S. Kisch . 206
A Possible Ecological Effect of Upwelling in a Submarine Canyon.—Raymond J. Ghelardi and Wheeler J. North . . . 207
Monte Carlo Analyses of Genetic Models.—A. S. Fraser . . 208
An Experimental Design for Three Factors at Three Levels.—Robert M. de Baun 209
Vowel Recognition in Clipped Speech.—Rais Ahmed . . . 210



Do you need

one copy – or several?



Every organisation has its own particular document-copying requirements, so you alone can decide which copying method would be most suitable for your purposes.

For example, is time a very important factor? Would you require one copy of a document, or several? Would originals be single-sided or double-sided? Who would use the equipment? Would copies have to be despatched immediately? These and other factors must influence your choice.

So before you start buying, get in touch with Kodak, who have an immense amount of document-copying experience behind them. They will provide you with a great deal of information that should help you to select the most suitable method for your particular needs.

Kodak

Kodak Limited, Industrial Sales Division, Kodak House, Kingsway, London, W.C.2

DIRECT READING pH METER

MODEL 23A

This high-grade laboratory pH Meter is one of the most widely used instruments in electrochemical research.

Some 50 different types of electrodes are available for pH, redox and micro analytical work. Stable to 0.02 pH with a B.S. precision grade meter and a recorder output.

E·I·L the pH people

ELECTRONIC INSTRUMENTS LIMITED • RICHMOND . SURREY . ENGLAND

RIChmond 5656

E.7

PROBLEMS OF GOVERNMENT IN THE MODERN WORLD

FOR something like two decades at least, it has been widely recognized in Britain that Ministers and the higher Civil servants have been seriously overworked. Indeed, the Haldane Report on the Machinery of Government in 1918 urged the importance of more provision for investigation and thought as a preliminary to action, and this is the proper approach to a problem that in recent months has been described as one of reducing the burden on Ministers.

It was suggested to the Prime Minister in April last that he should appoint a Select Committee to review and inquire into the working of the present system of government with the view of reducing the burden on Ministers and also securing the more efficient working of Parliament. After studying the suggestion, Mr. Macmillan invited a small group of Privy Councillors with long experience of the House of Commons to make a preliminary informal study of these problems under the chairmanship of Lord Attlee. Their report was presented early last autumn, and Mr. Macmillan stated on November 5 in the debate on the address from the Throne that he was satisfied that no further inquiry is required and that the problem is one of adapting existing practices to the best advantage. He said further that it is not easy for Ministers in charge of departments to retain full responsibility, as they must, and at the same time take complete advantage of the help that Parliamentary Secretaries and Ministers of State can give. If such Ministers are really to be regarded as deputy Ministers they must be recognized as having such authority, and he thought that this might be the biggest single contribution to the reduction of the burden on senior Ministers. Mr. Macmillan suggested that members of the House might accept such Ministers as the spokesmen of their Departments. Independently of this, the Prime Minister was specifically challenged on October 29 about the responsibilities of the Lord President of the Council. The Opposition was plainly dissatisfied at the combination of the major departmental responsibilities for the nation's scientific effort with party political duties; but the matter was raised in too partisan a manner to bring out the real reasons for concern.

Those reasons appear much more clearly in a survey by a study group of the Royal Institute of Public Administration which has been published under the title "The Organization of British Central Government, 1914–1956"* since the Committee of Privy Councillors began its inquiry. Particularly in its chapters on the central administration, the central co-ordination of Government and the handling of administrative change, it supplies the background for fruitful discussion of the current problems of government, while the chapter on scientific research provides a coherent picture of the organization in Britain for research. This is of special importance at the present time in view of the survey on which the Advisory Council for Scientific Policy is already engaged, and also because of its bearing on effective scientific co-operation with the United States, to which the Prime Minister and President Eisenhower have committed us.

The Prime Minister, however, made two remarks in referring to the accident at Windscale which are profoundly significant in this connexion. In replying to questions arising out of his statement on November 8, he remarked that on the purely technical atomic aspects of the accident, he had chosen Sir Alexander Fleck to be chairman of the three committees because he had sufficient scientific knowledge of a general character. Secondly, when asked on November 12 whether, in view of the fact that responsibility for nuclear energy matters involves much detailed study of highly technical problems, he would consider transferring that responsibility from himself to a senior Minister in the House of Commons, he replied that he thought the existing arrangement is the most suitable at the present time. Pressed again that in principle it was wrong that the Prime Minister should be burdened with detailed affairs that are bound to arise from time to time in an organization such as the Atomic Energy Authority, Mr. Macmillan admitted that there are disadvantages. Nevertheless, he thought that, for the present, when the various uses of nuclear power are so much in the field that the Prime Minister of the day must in any event have them under his control, there are advantages, and that on the whole the system works well. In the detailed work he was much helped by the Paymaster-General.

Now there are at least three implications in these remarks that bear profoundly both on the whole conduct of government and on its organization in relation to the nation's scientific and technological effort. Implicit in the reason given for his choice of Sir Alexander Fleck and in his reason for retaining as Prime Minister special responsibility for nuclear energy is the fundamental importance of some personal understanding of science and technology on the part of Ministers and of their chief permanent advisers. Consciously or unconsciously, Mr. Macmillan underlined the vital point which Sir Henry Tizard made in his Haldane Memorial Lecture. Without such understanding of science on the part of Ministers and members of the administrative class of the Civil Service, there cannot to-day be secured that effective relation between knowledge and power, and between expert and responsible Minister, upon which the smooth functioning of any system of government depends.

* The Organization of British Central Government 1914–1956: a Survey by a Study Group of the Royal Institute of Public Administration. Edited by D. N. Chester. Written by F. M. G. Willson. Pp. 458. (London: George Allen and Unwin, Ltd., 1957.) 32s. net.

The first task is thus attention to the educational system—and at all levels—not simply to secure the supply of sufficient scientists and technologists, but also of Ministers, administrators and citizens who are able to appreciate the significance of what the scientist or technologist is doing, and of scientists and technologists who are capable of taking broad views and of explaining the significance of their investigations in terms which those working in other fields can understand. This is an urgent task and of over-riding importance. While its results may well be long-term, the course of Anglo-American co-operation and Britain's security, as well as her economic future, largely depend on the vigour and vision with which it is undertaken.

Next, there is implied the necessity of considering the scientific and technical aspects of public affairs at the highest—at the policy-making—level. This is not to say that the scientist or technologist as such should be present in the Cabinet; but it does involve the presence at that level of those who are competent to evaluate at first hand the advice on such matters that their experts have given them. It is difficult to believe that the Advisory Council on Scientific Policy or the Defence Research Policy Committee has failed for the past ten years to present its advice cogently and intelligibly, though the published reports of the former body suggest that on occasion it might have been expressed more firmly or forcibly. It is much more probable that its significance and especially the urgency of action in such matters have rarely been appreciated at Cabinet-level, and matters have usually been allowed to drift, with waste of precious resources, until some less-effective measure has had to be adopted, often with further waste and frustration.

This view is supported by the picture which is presented in the chapter on scientific research in "The Organization of British Central Government, 1914–1956". That chapter traces the development of government institutions which have been specially established to conduct—and to encourage private institutions to conduct—scientific research primarily for civil purposes; but it also discusses succinctly some of the problems which have been raised by the assumption of this new Government responsibility. Sufficient is said about the University Grants Committee to show that the arrangements for co-ordination of the resources for fundamental research are quite loose, and that without real understanding and insight at the Treasury and on the part of the Lord President of the Council, not only is overlapping possible, but also and more important, research of outstanding significance can be restricted by economy measures dictated by those with no direct responsibility for the work or appreciation of its bearing on the national welfare or economy. The importance of co-ordination is implicit in the remarks of the Prime Minister, though he did not indicate that he proposed to improve the existing arrangements.

Several types of authority have been established over the years to deal with government policy in scientific research. It seems to be generally admitted that the orthodox type of government department is not suitable where research is concerned. What stands out above all, however, is the dependence of the structure as a whole upon the vision, understanding and influence of such men as Lord Balfour and the late Lord Waverley. Where such interested and strong personalities have held the office of Lord President, the system has manifestly worked; in their absence it is difficult to believe, on this record, that a theoretically perfect organization would have yielded better results.

The conclusion is drawn from this survey that the research authorities should have a high degree of autonomy and be regarded as institutions with entirely non-political functions, the necessary minimum of control being exercised on behalf of Government and Parliament by a Minister with no departmental responsibilities and consequently no departmental prejudices—namely, the Lord President of the Council. For that reason, it would seem a sound decision to transfer to the Minister of Power the responsibilities for nuclear energy which the Lord President held from January 1954; but it is more debatable whether the responsibilities for nuclear research should also be transferred, particularly in the present situation, when the balance of research and development effort is in question. The Lord President seems better placed than any other senior Minister to determine whether the resources allocated to nuclear research and the development of nuclear energy, both under the Atomic Energy Authority and elsewhere, are excessive or not. The responsibility is immense, and the real criticism made of the structure up to April 1957 was that the Lord President was ill-provided for such responsibility either in respect of staff or spokesmen in the House of Commons; nor does it seem satisfactory that there should still be two indirect spokesmen—the Parliamentary Secretary to the Minister of Works and the Paymaster-General. The conception of a Minister of Science has been rejected for valid reasons, but the case for providing the Lord President of the Council with such an organization and staff for research and intelligence generally as the Haldane report recommended seems unanswered.

Until the outbreak of the Second World War the Lord President, despite his special responsibility for the research councils, was only slightly in evidence as a scientific co-ordinator, and the prestige which Lord Salisbury's predecessors in that office enjoyed was largely built up when Sir John Anderson, as he then was, was Lord President, from October 1940 until September 1943, and acted as chairman of two standing committees, one on economic information and one on scientific research. Later, in 1947, the economic responsibilities were relinquished and about the same time the Advisory Council on Scientific Policy and the Defence Research Policy Committee were established. Moreover, from January 1956 until April 1957, besides carrying responsibilities for the major scientific organizations, the Lord President presided over the Cabinet Committee on Atomic Energy, consisting of those Ministers who have a

share of responsibility in the activities of the Atomic Energy Authority, and probably others, and he was assisted by an official committee of high Civil servants drawn from the corresponding departments.

Thus far the survey made by the Study Group of the Royal Institute of Public Administration scarcely supports the manner in which scientific policy has been handled by Government in recent years; and it points to the wisdom of a suggestion made by Sir John Anderson in his Romanes Lecture of 1946, that a section of the Cabinet Secretariat should be organized to assist the Lord President as the Minister responsible for the general aspects of scientific investigation, thus providing scientific advice at the highest level without prejudice to the work of departmental scientific staff. But the discussion of the handling of administrative change in general is even more pertinent to the question of lightening the burden on Ministers and facilitating deeper thought on policy and problems of change now under consideration by the Prime Minister. There is indeed no simple formula by application of which all problems of administrative arrangement can be solved. The structure of central government and the distribution of functions among departments is the resultant of numerous factors. Obviously, the number of Ministers will be determined ultimately by the responsibilities which the central government is required to assume, and on the whole it is remarkable, with the great increase in government activity during the past forty years, that the number of Ministers has increased no more than from twenty-one in 1914 to twenty-nine in 1956.

It would not appear from the Prime Minister's comments so far that he intends to enter on any discussion either of the two powerful forces which since 1914 have dominated this struggle about the number of Ministers, or again of the four main ways in which Government powers and activities may be grouped for administrative purposes. It could perhaps be inferred that he himself gives greater weight to the needs of co-ordination and the advantages of government by a small and well-knit body of Ministers and also that he attaches greater weight to the purpose to be served than to the kind of work to be undertaken. That again might be less important if there were evidence that Governments could count on a succession of Lord Balfours and Lord Waverleys competent both to give due weight to the scientific and technical elements in affairs of state and also authoritative enough to ensure that the conditions in which scientific research is most fruitfully pursued are preserved and that adequate resources are available.

Although the essential factors to be considered in handling changes in the administrative structure are set forth in this book with admirable lucidity and in a way that could reduce the possibility of an inefficient allocation of functions, the Study Group of the Royal Institute of Public Administration is careful not to suggest excessive attention to this aspect. On the whole, it seems satisfied with the present arrangements within the Treasury for handling such questions, and considers that the structure has been changed and extended with a fair degree of success to meet the conditions of to-day. Problems indeed remain: more use might be made of men and women of affairs outside the Civil Service, and also of students of public administration, as indeed was envisaged in a Government pledge of 1948. It also advocates the publication from time to time of a report surveying the changes in the machinery of government during the period covered, and giving as much information as possible as to the reasons for the changes and about any studies or inquiries conducted since the previous survey.

Such publicity is a pre-condition for the informed discussion which alone can put at the disposal of the Government the full range of experience and the profoundest thinking available in the nation; and it should be kept in mind by Mr. Macmillan in considering the publication of the report of the Committee of Privy Councillors, and indeed of those of the Machinery of Government Committee. Although the process of adaptation is now more conscious than formerly, and more attention is paid to the broad plan of organization on which Ministers rely for the discharge of their powers, efficiency will be promoted by constant study of the factors influencing the structure of government, subject always to the need for flexibility.

The beginning of wisdom in this context, this study affirms, is the firm rejection of any belief in the possibility of defining a rigid and comprehensive framework of organization into which every function of government can be fitted for all time. Perhaps one of the gravest dangers, as we have seen on occasion in respect of the nationalized industries, is that flexibility or other principles of sound administration may be disregarded through party political prejudice or some other partisan view.

The issues raised by the Prime Minister's statement as to the responsibilities and duties of Ministers go right to the heart of the efficiency of government. Part of the problem lies in relieving the central government of detailed work which is best carried out regionally or locally, and that in turn depends on restoring vitality and efficiency to local government. Here, too, is a problem of communication, and in that respect it would appear that we have far to go to secure really effective contact and understanding between the centre and the perimeter. Nor is this solely a matter of seeing that our rulers and administrators are appropriately educated: at least in part it is a matter of ensuring that full use is made of the possibilities of communication and interpretation now at our disposal.

The vital need at the present time is for an educational system, perhaps on the lines put forward in general terms by Sir Eric Ashby, Dr. J. Bronowski and Dr. R. P. Linstead in recent addresses, which will provide the nation with leaders capable of assessing all aspects of the problems which the modern world presents, and wise and strong enough to resist sectional pressure.

A SYNTHESIS OF GENERAL EMBRYOLOGY

Introduction to General Embryology

By Prof. A. M. Dalcq. Translated by Jean Medawar. Pp. vii+177. (Oxford: Clarendon Press; London: Oxford University Press, 1957.) 25*s*. net.

THIS "Introduction to General Embryology" is the outcome of a series of thirteen broadcast talks given by Prof. Albert Dalcq in 1951 at the request of the "Université radiophonique" of Paris. These lectures were published in French by Prof. Dalcq in 1952, under the title "Initiation à l'Embryologie générale". This small book soon became a classic for students—not only Prof. Dalcq's own, but also for those of his former students who, like the present reviewer, have the task of teaching experimental and chemical embryology in university courses. In fact, Prof. Dalcq's book is much more than an introduction to embryological problems; it is a masterly synthesis of our present knowledge in the field, as well as the expression of the scientific and philosophical ideas of one of the world's leading embryologists. The translation of Prof. Dalcq's book into English is especially welcome, since the author has brought up to date the first nine chapters of the French edition, has rewritten the remainder and added a new chapter devoted mainly to his recent important work on mammals.

Prof. Dalcq starts with a question that is puzzling for too many laymen: Why should one study embryology? After showing the importance of this science for practical (artificial insemination) and medical purposes, he emphasizes the close relationship existing between embryology and allied disciplines (cytology, genetics, study of evolution). He points out—and this is one of his favourite ideas—that the main abilities of the human mind are all inborn: the nature of psychic activity might be discovered from studies made on the embryo. It is perhaps one of Prof. Dalcq's secret hopes that a psychological analysis of the developing embryo will some time become a reality.

Chapter 2 is a clear and brief account of the history of embryology. The reader is immediately placed in the middle of the eternal preformation *versus* epigenesis controversy. The next chapter is devoted to the methods used by present-day embryologists.

In Chapter 4, the main cellular constituents, at the morphological and biochemical levels, as well as the formation of the gametes, are briefly described. The next chapter deals mainly with fertilization and parthenogenesis. The title of Chapter 6 is "A Discussion of Terminology": after describing cleavage and gastrulation, Prof. Dalcq concludes that ontogenesis begins necessarily with immediate or delayed cleavage; morphochoresis corresponds to both gastrulation and neurulation; it is followed by cytodifferentiation and growth.

The next chapters introduce the reader to the realm of experimental embryology. The classical experiments in which one of the blastomeres of the two-cell stage is destroyed, or in which the two blastomeres are separated from each other are clearly described and discussed. The significance of, and the difficulties inherent in the use of, such terms as mosaic and regulative eggs are stressed. Prof. Dalcq also explains what he means by "normogenesis" and "parageneis"; normogenesis and regulation are at the two extremes, while parageneis corresponds to the intermediary anomalies of development, including exogastrulation, morphogenetic induction in vertebrate eggs, vegetalization or animalization in those of the sea urchin, etc.

In Chapter 10 the author analyses the many aspects of induction and introduces the very useful concept of "morphogenetic potentials". This is followed (Chapter 11) by a very interesting study of mammalian development, including Prof. Dalcq's important studies on the cytochemistry of these eggs.

The scope becomes still broader in the next two chapters, which are devoted to the relationship between development, heredity, and evolution. Finally, in the last chapter, "Where do we stand?", Prof. Dalcq brings together many facts derived from studies of asexual reproduction, regeneration, and embryonic development. He finishes this attempt at synthesis with a few remarks that summarize his philosophy of life and the living.

One must heartily congratulate the translator, Mrs. Jean Medawar, on her expert job. Prof. Dalcq's style is elegant, elaborate, and precise. That all these qualities are found again in the English text deserves admiration. The presentation of the book is excellent and there are next to no typographical errors. Thanks to the quality of the paper, the reproduction of text figures (many of them original and slightly schematic) is much better than in the original French edition.

J. Brachet

AGRICULTURE IN EAST AND WEST

Types of Rural Economy

Studies in World Agriculture. By Prof. René Dumont. Pp. xii+556. (London: Methuen and Co., Ltd., 1957.) 45*s*. net.

PROF. DUMONT is already well known for his studies of French agriculture: in this volume he ranges over a much wider field, including England, most of Europe, North and West Africa and northern Viet Nam, always, however, confining himself to places he has actually visited. The book is thus a series of vignettes, but the background is always broadly sketched in to keep a sense of proportion. In a disarmingly modest preface he describes the volume as a "preliminary exercise" by one who undertook these economic studies "too late in life to have acquired a really profound knowledge of them", but the apology is quite unnecessary: the most expert reader will gain a great deal from its pages.

The author's keen power of observation, and his ability to pick out and emphasize the essentials of the various systems described, give the book an exceptional value. He is equally interesting and informative whether he is dealing with the collective farms near Moscow and in Eastern Europe, the corridor system in the Belgian Congo designed to overcome the defects of the native shifting cultivation, or the skilful adaptation of agricultural systems to environment in the Alps.

He makes some shrewd and penetrating comparisons of British and French agriculture, one worked by tenant farmers, the other by peasants: characteristically he began his studies by working as a labourer on a small Shropshire farm. The English farmer, he found, operates on a larger scale, reduces manual labour to a minimum by heavy mechanization

(the heaviest in the world, he states), prefers tenancy to ownership because he wants to use all his capital for working and development, devotes himself entirely to management, leaving the manual operations to the staff, and enjoys a social status such that "it would not be considered unusual for him to marry a woman qualified in law or medicine. In France," the author adds rather wistfully "things are quite different." British agricultural policy he regards as the most enlightened in the world; it encourages high output and rural prosperity, and he specially notes that some of the farm workers had motor-cycles or even cars. But he foresees future troubles: we can produce only about half our food and must import the rest; our industrial supremacy has gone, and the terms of trade are moving steadily against importers of food.

Like others who know them, he praises highly the land reclamations in Holland, the most impressive in the world, though with the reservation that urban developments are throwing land out of cultivation more rapidly than new land is brought in: better urban planning could avoid this. Also he is doubtful about the ethics of British and Dutch nurserymen who between them burn a million tons of coal a year to grow early grapes and other fruits—purely luxury products: if the buyers would only wait a month or so they could obtain better flavoured fruits from the Mediterranean countries. Actually by far the chief products are tomatoes, cucumbers, lettuces, and other salads badly needed in our diet.

Italy deservedly receives considerable attention: no other country is experimenting with so great a variety of agricultural economic systems to deal with the problems of too many people multiplying too rapidly and trying to live on too few resources. The range is widened by the circumstances that the natural conditions are favourable in the north but become less and less so in travelling southwards. Individualist, communist, co-operative, metayage, mandatory labour, and other systems are under trial.

Having completed his wide survey ranging from primitive African to intensive Western European systems Prof. Dumont summarizes his conclusions. The greatest obstacle to agricultural progress lies in the smallness of the units in many countries. He is all in favour of the large, indeed the very large farm, and prefers the Russian collective or the Eastern European group-cooperative to the Western capitalist system, but only on the condition that membership be genuinely voluntary. He sees, however, the danger that it may foster the growth of a swollen and incompetent bureaucracy. Against the large capitalist farm are the facts that it is based on the profit motive, which he heartily dislikes, and that the workers lack the spur of personal interest—he does not discuss bonus payments. Whatever the system, however, capital must come in from outside to provide the necessary equipment: he gives striking examples showing the enormous benefit thus conferred. Prior to 1820, there was, perhaps, a ten-fold difference in efficiency between the various systems of agriculture in the different countries he has studied: the production of one cwt. of grain required about three-quarters to 7½ days of labour. The native African and Asian systems still require this. But in the highly developed countries the difference is enormously widened: it is no longer tenfold but more like forty- or fifty-fold; indeed, in the Corn Belt of the United States 5 hours' labour suffices to produce 24–48 cwt. of hybrid maize. The British reader will note that the period concerned corresponds exactly with that of industrial development, and will draw the conclusion that industrial and agricultural development must proceed *pari passu*, that agriculture advances best where workers can be taken off the land and put into factories to provide it with capital and to make the implements, the fertilizers, pest- and weed-control and other agents necessary for high output; when also a teaching organization has been developed to educate the farmers and farm workers, and a research organization to discover the principles governing the growth of plants and of animals so that new and better methods may constantly be devised and tested. Prof. Dumont prefers to insist on a fundamental re-orientation of national effort: the substitution of the present system of economy based on profit for one based on the fight against world hunger. This would necessitate a planned economy imposed on large-scale units operated on liberalized communist lines which he thought he saw emerging, and for which he pleads in an eloquent peroration. But this was written in 1953: in a postscript added in 1957 he sadly records the shattering of his hopes by the tragic events in Budapest.

The book is extremely interesting, written in the best French tradition of idealism tempered by a shrewd sense of the practical. Mr. Douglas Magnin, the translator, has done his work well, and his text reads as smoothly and persuasively as the original.

E. John Russell

THE CHEMISTRY AND BIOCHEMISTRY OF THE REDUCTONES

Chemie und Biochemie der Reduktone und Reduktonate

Von Prof. Dr. Hans von Euler und Prof. Dr. Bernd Eistert. Pp. xi+344. (Stuttgart: Ferdinand Enke Verlag, 1957.) 47.40 D.M.

THE compounds designated reductones contain the grouping R—C(OH)=C(OH)—R'. As would be expected from their structure they display intense chemical reactivity, notably in their reducing power towards reagents such as dichlorophenol-indophenol (Tillmans reagent). The endiol grouping is found in a wide variety of organic substances, including both synthetic materials and substances of natural origin. One of the most important of these is L-ascorbic acid (vitamin C) and interest in the very novel problems encountered during the study of ascorbic acid and its analogues stimulated investigations into the general problems of reductone chemistry.

In the present volume three of the principal workers in the field, namely, H. von Euler, B. Eistert and H. Hasselquist, have collected together information from a wide range of publications and have presented it in a form which makes it readily available to other workers in this field. A brief glance at the lengthy list of names of authors and substances given in the index and at the very numerous references to original papers recorded page by page in footnotes will suffice to show that their task has been truly formidable. An astonishing variety of topics is discussed in the course of twelve chapters and a short appendix. Methods for the recognition and determination of reductones are given in detail in the first chapter, followed by a chapter on the endiol forms of the aliphatic and

aromatic acyloins. This leads to a discussion of the complex forms of tautomerism displayed by the reductones. There are detailed accounts of the chemistry of the simplest member (triose reductone) and its derivatives, of reductones containing thiol or amino groups, aromatic and heterocyclic reductones, vinyl-homologues of reductones, and substances of the reductic acid type. Two of the main chapters are devoted to ascorbic acid and its derivatives, and to a consideration of the biochemistry of vitamin C and its analogues.

The book will be of great value to all whose work involves compounds containing the endiol system (—C(OH)=C(OH)—) or its dehydro form (—CO—CO—). Clear accounts are given of the theoretical background to the synthetic reductones, but in the important case of L-ascorbic acid one looks in vain for a connected statement of the evidence upon which the accepted structure is based. The necessary information is indeed recorded (although in ref. 7 on p. 196 the name of the journal is incorrect), but it is found in various places, and there is little indication of the many fundamental problems presented by the chemistry of ascorbic acid and its analogues.

In the chapter on biochemical aspects—where admittedly the number of possible references is legion—it is a pity that an omnibus reference to a review article (p. 305) should tend to obscure the very important part played by S. S. Zilva in the development of our knowledge of vitamin C. In view of the recent work by Calvin, it is doubtful whether many chemists would agree that glycolaldehyde (p. 298) or formaldehyde (p. 309) can be regarded seriously as precursors of the carbohydrates in photosynthesis. One feature is, however, well brought out in this section—namely, the extraordinary complexity of the problems involved in ascertaining the biological role taken by L-ascorbic acid and the little progress that has been made in this field despite all the efforts of the past few years.

It is clear that the reductone system still holds many important secrets both for the chemist and the biologist to uncover. E. L. Hirst

PHYSIOLOGICAL OPTICS

Light, Colour and Vision

By Prof. Yves Le Grand. Approved translation by Dr. R. W. G. Hunt, Dr. J. W. T. Walsh, and F. R. W. Hunt. Pp. xiii+512. (London: Chapman and Hall, Ltd., 1957.) 63*s*. net.

THIS book is a translation of Vol. 2 of Prof. Le Grand's "Optique Physiologique", and the first word must be one of congratulation to the team of translators. They have done a first-class job, as we might indeed expect they would, and they can derive much satisfaction from the fruit of their very considerable labours. There has evidently been close and cordial co-operation between author and translators, and the opportunity has been taken to report work of more recent date than 1948, when the French edition was first published.

The book is essentially a survey of researches on visual perception, with the main emphasis on colour vision. Comparison with Helmholtz's "Physiological Optics" is suggested on the jacket, but perhaps a more valid parallel would be with Parsons's "Colour Vision". Certainly, Sir John would have rejoiced, if he had lived a few weeks longer, to have seen the publication in Britain of this worthy successor to his own book, which was itself a landmark in the development of the subject.

The contents are divided into two Sections, with Section *A* headed "Experimental Facts", and Section *B* "Theories of Vision", but the merits of this division are not too clear. Thus, of the five chapters comprising Section *B*, three of them deal with the anatomy, the photochemistry and the electrophysiology of the retina respectively, and are primarily factual rather than theoretical. On the other hand, in the fifteen chapters comprising Section *A*, covering radiation, photometry, colorimetry, normal and anomalous colour vision, thresholds of various sorts, and spatial and temporal effects, a number of theoretical tit-bits have crept in.

One of the most effective of these is on p. 271, where the author discusses Fechner's integration of discrimination steps to produce a scale of sensation *S*. He concludes that "it may be questioned whether there is any reality in this quantity *S* which has lost all the attributes that are needed for a scale of constant intervals and that were assigned to it by Fechner in order to define it". In spite of this denunciation, the logarithmic relation between stimulus and sensation will no doubt continue to plague us for many years to come.

Le Grand's balanced account of colour vision theories does not conceal the fact that he himself is a Young–Helmholtz 'three-components' man and he regrets the disfavour into which Young's theory has undeservedly fallen among certain physiologists. Of the zone theories which are an elaboration of Young's theory, he recognizes that they may correspond with physiological facts, but that only experiment can confirm or deny this. He also reminds us that whatever the retinal basis for colour discrimination may be, the identification of the messages between retina and brain, and their decoding in the brain, have still to be explained.

Occasionally, Le Grand's judgment seems to falter, as when he suggests on p. 287 that all colour threshold problems can be solved from the discrimination ellipses in the chromaticity chart. Again, the manner in which on p. 302 he brushes aside after-images as an annoyance to the physicist, apparently unworthy of his study, is somewhat out of keeping with the general tenor of the book. Then his reference on p. 336 to the experiments by Horner and Purslow, in which the size of field was found to affect the red-green mixture required to match a yellow in the Nagel anomaloscope, does not explain that their observations were made with an unrestricted natural pupil and with the observer stationed at various distances from the anomaloscope field. The phenomenon is of very real interest, but it seems to be connected more with the pupil diameter than with the size of field, since the same effect is not observed with an instrument using an artificial pupil.

But these are minor criticisms of what is undoubtedly a very fine book. It is written by a physicist who has himself made notable original contributions, both theoretical and experimental, to the subject of vision, and who has taken a keen interest in its historical background. Above all, he brings out the mystery which still surrounds most visual problems and which adds so much to their attraction. For their complexity and inherent scientific interest, they compare favourably with the problem of launching a *sputnik*, their study is far less expensive and their solution is happily not a matter involving national military prestige. W. D. Wright

Organic Reactions

Vol. 9. Edited by Roger Adams, A. H. Blatt, Arthur C. Cope, David Y. Curtin, Frank C. McGrew and Carl Niemann. Pp. viii+468. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 96*s*. net.

EVERY new volume in this series, which began in 1942, receives a warm welcome from research workers, teachers, and advanced students concerned with reactions capable of wide application in organic chemical synthesis. Many such reactions find repeated mention in text-books and laboratory manuals of organic chemistry; but usually such references are confined to a specific application, give no general survey of the scope of the process concerned, and fail to indicate its limitations, disturbing influences, and variations of practical technique. These omissions are fully met in "Organic Reactions", every volume of which contains a series of chapters each devoted to a single reaction, or sometimes to a definite phase of a reaction, of outstanding synthetic importance.

The seven chapters of the present volume, written, as usual, by workers actively engaged in the several fields, deal with the cleavage of non-enolizable ketones with sodium amide, the Gattermann synthesis of aldehydes, the Baeyer-Villiger oxidation of aldehydes and ketones, the alkylation of esters and nitriles, the reaction of halogens with silver salts of carboxylic acids, the synthesis of β-lactams, and the Pschorr synthesis and related diazonium ring-closure reactions. The account of the alkylation of esters and nitriles is by far the longest of these contributions: discussions of mechanism, scope, methods, and experimental conditions, are supplemented by twenty tabulated summaries giving the alkylating agent, product, yield, and base for an extensive variety of specific esters and nitriles. This chapter alone contains more than a thousand references to the original literature; and, in general, the work is admirably documented and indexed.

JOHN READ

Mathematics and Statistics for use in Pharmacology, Biology and Chemistry

By L. Saunders and R. Fleming. Pp. x+257. (London: The Pharmaceutical Press, 1957. Published by direction of the Council of the Pharmaceutical Society of Great Britain.) 27*s*. 6*d*.

THE authors have attempted to provide a course adequate for honours students in pharmacy whose mathematical knowledge is slight. Early chapters summarize the elementary rules of indices and logarithms and principles of algebra and graphs. Differential and integral calculus, trigonometry, and differential equations are all covered within 110 pages. Apart from some carelessness of phrasing, such as describing a determinant as an operator, the text seems sound, though naturally without mathematical rigour. Whether it could in fact be understood by the students for whom it is intended is more doubtful; it seems more likely to be of service to graduates who have previously studied mathematics more thoroughly but who need a much-condensed revision course.

The second half of the book is concerned with probability and statistics, and is less satisfactory. The text is marred by a number of wrong or misleading statements about populations and samples, expectation, degrees of freedom, and other fundamental ideas. It is difficult to imagine these chapters as adequate even for revision purposes, although the extent of the statistical methods that the authors regard as important for pharmacists is encouraging. The final chapter on quality control and acceptance sampling of pharmaceutical products and errors of dispensing is by far the most interesting in the book; this certainly deserves careful study, and could usefully be developed more fully.

D. J. FINNEY

The Support of Medical Research

Edited by Sir Harold Himsworth and J. F. Delafresnaye. (A Symposium organized by the Council for International Organizations of Medical Sciences.) Pp. xi+170. (Oxford: Blackwell Scientific Publications, 1956.) 17*s*. 6*d*. net.

THIS book is a report of a conference which the Council for International Organizations of Medical Sciences held in London late in 1954 under the joint auspices of Unesco and the World Health Organization. The meeting was well attended, and provided the participants with an opportunity for informing each other how research councils and similar institutions operate in their respective countries. It also made possible the statement of views on the desirability of medical research in universities being financed both directly out of university funds and out of subventions from outside bodies, such as the Medical Research Council in Great Britain. The several ways by which central research organizations can support medical research were also discussed, as was the training and recruitment of medical research workers. Appendixes to the book provide brief accounts of the arrangements for medical research which exist in the countries represented at the conference.

Buried Treasure

By Paul Johnstone. Pp. iii+67 plates. (London: Phoenix House, Ltd., 1957.) 16*s*. net.

WITHOUT doubt the television programmes on archæology, organized by Paul Johnstone, have much increased the general interest in the subject. His advisory panel has consisted of experts in the various aspects of the study with the result that viewers have had of the best and not merely second-hand material. The book under review is an account by Johnstone of the various programmes he organized. Piltdown was long supposed to be the earliest human skull found; the exposure created a stir which spread well beyond purely scientific circles. It was right that the story of Piltdown and its true significance should be given in the first chapter. But though Piltdown has had to go, there still remains *Australopithecus* in South Africa, and it is logical that a study of this early creature should follow. The earliest appearance of art and how the artists worked continues the story into late Pleistocene times. Accounts of Jericho, the neolithic stone temples in Malta, Stone Age house building, and the great West Kennet Long Barrow come next; and this leads on to a description of the recent work done at our greatest stone monument of all, Stonehenge. Finally, there are chapters on the Etruscans, on the Gaulish finds at Châtillon-sur-Seine, on Maiden Castle near Dorchester, and on the discoveries made in the Tollund peat bog in Denmark of the well-preserved body of a prehistoric (Iron Age) man. The book is richly illustrated, and there is a short bibliography.

M. C. BURKITT

DR. IRVING LANGMUIR'S CONTRIBUTIONS TO PHYSICS

By Dr. ALBERT W. HULL
General Electric Co., Schenectady, New York

SIR ERIC RIDEAL'S excellent tribute to Dr. Irving Langmuir (*Nature*, **180**, 581; 1957) emphasizes, very properly, his contributions to chemistry. To those of us who had the privilege of working with him, Dr. Langmuir was unsurpassed also as a physicist; and could equally well have received the Nobel Prize for his contributions in physics.

Sir Eric has mentioned Langmuir's study of the loss of heat from electrically heated wires in gases. This had been the subject of his Göttingen Ph.D. thesis—a very unexciting subject, but see what it led to in his hands! On coming to the General Electric Research Laboratory, he was quick to grasp the opportunity afforded by Coolidge's development of drawn tungsten wire, and spent the first three or four years carrying heat-loss studies to higher temperatures. At one point Dr. Whitney, director of the Laboratory, had to defend Langmuir before the board of directors, who thought he was wasting his time. "You leave Langmuir alone," Dr. Whitney said; "he is doing good work." The results proved it.

One of these results was his equation for heat loss, which he represented as conduction in a stationary film around the wire, with convection outside this film. In discussing this equation with him soon after its publication, I commented that the mechanism seemed artificial. He made the excellent reply: "What difference does it make, provided it gives the right result?"

Shortly thereafter he justified this theory by calculating, and then demonstrating experimentally, that the loss of heat from a lamp filament in nitrogen at atmospheric pressure could be made even less than in vacuum by coiling the wire in a tight helix, thus effectively increasing its diameter and hence the thickness of the 'stationary' film.

It was inevitable that Langmuir should observe a deviation from this equation in the case of hydrogen, namely, a large increase of heat loss above 2,200° C. This he explained correctly as due to the dissociation of the hydrogen into atoms. It was several years later when, in response to a letter from R. W. Wood, asking why a platinum wire in a remote part of a tube carrying a glow discharge in hydrogen should become white hot, Langmuir answered at once, "Association of hydrogen atoms to molecules at the wire". Thinking of this, Langmuir reasoned that if the dissociated hydrogen from an arc discharge were blown against a metal a great deal of heat could be delivered to it—the hydrogen welding torch.

Langmuir's interest in tungsten filaments led him, in 1912, into electronics, the field that was to prove so fruitful in his hands. Several years previously, O. W. Richardson had published his famous equation of electron emission. Langmuir noted that this equation predicted for tungsten, near its melting point, an electron emission of several hundred amperes per square centimetre. He tried it, and found not amperes, but only milliamperes. The emission followed Richardson's equation only up to a certain temperature, above which it became saturated and depended only on voltage. I happened to be visiting Langmuir when he made this discovery—I was teaching at the time. He described fully his experiments, with none of the secrecy that was not uncommon at some places at the time, and said: "It should be possible to apply Poisson's equation to this". He did, and the result was his famous law of electron space-charge, which became the basis for the great electronic tube developments that followed. He devoted considerable time to the calculation of accurate space-charge formulæ for cylindrical and spherical electrodes, and the voltage gradient in electron tubes, including the important voltage minimum resulting from the initial velocities of the electrons.

Early in his electron-emission studies Langmuir noted an enormous increase in electron emission when he used, instead of pure tungsten wires, the 'thoriated tungsten' lamp wire, to which ½ per cent of thorium oxide had been added to prevent large crystal growth and 'off-setting'. The observation itself was a tribute to his careful vacuum technique, in this case the immersion of the entire tube in liquid air to avoid contamination by water vapour from the glass. But his explanation of it is a marvellous example of his insight into physical phenomena. He visualized, and proved, that the thorium oxide is partially dissociated by the tungsten, releasing thorium atoms which diffuse to the surface and form a strongly adherent monatomic film, of lower work function than tungsten metal. These thoriated tungsten filaments are standard components of to-day's medium-power tubes.

A key feature of Langmuir's early research was good vacuum. The pumps available were clumsy and slow. In 1915, W. Gaede published an article on his 'diffusion pump'. Langmuir at once concluded that the action of this pump was not diffusion, but mechanical transport of the gas by mercury vapour atoms. He proceeded to design a high-speed 'condensation pump', in which a large blast of mercury vapour sweeps the gas before it, and then condenses on a water-cooled wall and runs back to the boiler. All high-speed high-vacuum pumps used in electronics and nuclear physics to-day embody this principle.

In 1922 Langmuir turned his attention to low-pressure gas discharges. He predicted and proved experimentally that a negatively charged electrode in a gas discharge is surrounded by a 'positive ion sheath', containing positive ions but no electrons; and that an insulated electrode must charge itself negatively, sufficiently to repel all but a small fraction of the electrons moving toward it; the amount for mercury vapour being 7–16 V., depending on the pressure. This showed that all previous measurements with probe electrodes had been in error by amounts of this magnitude. He then demonstrated, in a series of brilliant experimental studies, two correct methods of measuring potential in a discharge, one using a heated electrode, the potential of which is adjusted until the electrons

emitted by it are just able to escape; and the other a 'kink' in the semi-logarithmic plot of the volt–ampere characteristic of a cold probe. These methods have become standard procedures.

His quantitative theory of the positive-ion sheath showed why a negative voltage on the grid of a thyratron cannot interrupt the discharge, since each grid wire is surrounded by a thin positive-ion sheath that insulates it from the discharge.

He explained correctly the increase of pressure toward the anode end of a tube as the reaction of the oppositely directed momentum delivered to the glass walls by the positive ions.

Langmuir's classic studies of the adsorption of cæsium on tungsten, begun in 1923 and carried on intermittently for fifteen years, are a beautiful example of the combination of physics and chemistry in a pioneer investigation. The experimental part was physics, an extended series of measurements, first with K. H. Kingdon and later with J. B. Taylor, of the electron and positive-ion emission from tungsten wires in cæsium vapour. He predicted and verified experimentally that at high temperatures, where the work function of the clean wire (4·6 V.) is greater than the ionizing potential (3·9 V.) of the vapour, every cæsium atom that struck the filament left it as a positive ion; but that below 1,100° K. no positive ions were formed, because the fraction of the surface of the wire that was covered with cæsium reduced its work function below 3·9 V. Also that there was no positive-ion emission from a thorium-coated thoriated tungsten wire, the work function of which is 3·1 V.

The chemical part of the investigation included the use of a suitably modified form of the Saha equation for thermal ionization of a gas; and an adaptation of Gibbs's equation of state to two dimensions. With this powerful approach he predicted accurately not only the emission of electrons, ions and atoms as a function of temperature and density of adsorbed atoms, but also the spreading force of these 'adatoms', their heat of evaporation and the contact potential of the partially coated filament.

One more example of Langmuir's powerful, yet simple, application of physical laws was his calculation of the light-scattering power of 'white' smoke as a screening agent. Having previously developed, in his icing studies, a method of measuring particle size, he calculated from Rayleigh's law of scattering the optimum size of particle; and then, with V. J. Schaefer, produced particles of this size, with a screening power per gallon of oil many thousands of times greater than the black smoke then in use.

A final contribution, completed shortly before his death, was an exhaustive mathematical study of the probability of induced rainfall produced by periodic seeding of clouds with silver iodide.

I cannot conclude without an affectionate personal tribute to Irving Langmuir, as a loyal friend and stimulating colleague—inadequate words—to whose inspiring influence I owe a very great deal.

THE GEOLOGICAL SOCIETY OF LONDON

By Dr. W. CAMPBELL SMITH, C.B.E.

EARLY in 1807 a small group of men actively interested in mineralogy had been brought together by Dr. William Babington for meetings at his house. Several of these men had been members of the British Mineralogical Society (1799), which in 1806 had been incorporated with the still earlier Askesian Society.

This little group, with others, making thirteen in all, primarily interested in mineralogy but recognizing the need to learn about the wider fields of the then new science of geology, became the founders of the Geological Society of London. The meeting at which the Society was founded was held at the Freemasons' Tavern in Great Queen Street on November 13, 1807.

At the second meeting the Hon. C. F. Greville was invited to become patron, Greenough was elected president, and honorary members were elected from distinguished men of science in the British Isles. The honorary members numbered forty-two, of whom five were foreigners. Foreign members as such were not instituted until 1814. Among the first of these, elected in 1815, were Leopold von Buch, Cuvier, Haüy and Werner. Baron Humboldt was elected in 1817.

Six of the thirteen founders were Fellows of the Royal Society. These were Babington and Bournon, William Allen, founder of the firm of Allen and Hanbury, Humphry Davy, then secretary of the Royal Society, G. B. Greenough, a pupil of the celebrated Werner at Freiberg, and W. H. Pepys.

The new Society grew rapidly, and the lists of members elected in the early years are full of names now famous in science: W. H. Wollaston joined the Society in 1812, William Buckland in 1813, Sedgwick in 1818, Lyell in the following year, and Murchison and Faraday in 1824. Charles Darwin, persuaded thereto by Lyell, was secretary during 1838–41 and, coming to rather later days, T. H. Huxley during 1859–63.

A royal charter had been applied for in 1824 and was granted on April 23, 1825. There were then 372 elected members, of whom 260 were resident in or within twenty miles of London. The class of honorary members ceased with the charter. Except for a decline around 1857, after the Crimean War, there was a steady rise in the fellowship to 1,361 in 1881, after which numbers fell a little, reaching their lowest in 1942 (1,067). Thereafter there has been a steady rise to the present figure of 2,326 in 1957. This considerable increase may be attributable partly to the increased interest taken in geology in all the universities and its increasing application in some industries; it is also a result of efforts of the Council to make the Society more useful to geologists, prompted thereto by the suggestions made by three of its recent presidents.

There have been few changes in the rules for Fellows and Foreign Members. A new class of Foreign Correspondents, from which Foreign Members were elected, was made in 1863, but discontinued

in 1946. Women Fellows were not admitted until 1919, although proposals to this end had been made in 1889, and again in 1907 and 1909, and this in spite of the fact that many women geologists had made important contributions to the science, as indeed the Society had publicly recognized by various awards since 1893. A new class of Junior Associates was instituted in 1944 for men and women students of geology not less than eighteen and not more than twenty-three years of age.

The Society was very active from the start. Committees were set up to arrange the collection of minerals, to arrange for a uniform nomenclature, to prepare and collect mineralogical maps, models and sections of mines, and to approve communications previous to their being read before the Society.

The collection of minerals, rocks and 'extraneous fossils' grew rapidly and was of great use to the members. Its use particularly as regards British fossils was later superseded by the collection in the Museum of the Geological Survey, founded in 1835. Much work had been expended on arranging and cataloguing the Geological Society's collection by a succession of able and enthusiastic curators. A list of all the type-specimens was prepared by C. Davies Sherborn between 1891 and 1899, and a catalogue based on this list and edited by J. F. Blake was published in 1902. By this time the Library, which is one of the best in its field, was needing more space and in 1911, to make room for the books, the Society's collections were presented to the British Museum (Natural History) and the Geological Survey.

The Committee of Maps, appointed in 1809, does not seem to have been very active; but G. B. Greenough, first president of the Society, had started work on a geological map of England as early as 1808. This he presented in 1812; and it was published by the Society in 1820. The cost of drawing and engraving alone was £1,300.

It seems strange that the Society embarked on the preparation of this map, as it must have been known that William Smith had a geological map in hand. He was neither a member nor an honorary member of the Society, and he seems to have been almost ignored. However, the Society did something later to make amends for its early neglect of the 'father of English geology'.

W. H. Wollaston, who died in 1828, left the Society £1,000 to create a donation fund to aid or reward the researches of any individual or individuals of every country. The first use made of this fund was to strike a medal and to present the first Wollaston Medal to William Smith, together with the proceeds of the donation fund. Much later still, an annual William Smith Lecture was instituted. The first of these was given by W. W. Watts in 1945.

Other medals were founded much later: the Murchison (1871), Lyell (1875), Bigsby (1876), and at a still later period, the Prestwich Medal (1896). A fund was founded in 1876 by H. C. Barlow in honour of Prof. Robert Jameson, of Edinburgh. Many other bequests have been made for the encouragement of research in geology or for assistance in travel or with publications. They bear the names of the benefactors: Blanford, Daniel Pidgeon, Fearnsides, Garwood, Gloyne, Greenly, J. B. Tyrrell, Henry Woods and R. H. Worth; the last fund is especially for the encouragement of amateur geologists.

In 1945, the Anglo-Iranian and Burmah Oil Companies agreed jointly to place at the disposal of the Society a sum of money to be used to promote each year a geological tour for university students. The first of these tours was undertaken in 1946.

Apart from this, the Geological Society has not undertaken the organization of geological excursions. To the great benefit of all geologists this work was taken thoroughly in hand by the Geologists' Association, founded in London in 1858.

Quite early in its history the Society began publication of selected papers in the *Transactions*, 1811–56. These were in quarto and were profusely illustrated. There were long delays in printing the *Transactions*, and, in order to achieve a speedier reporting of papers read and of other geological news, *Proceedings* were published. These were first issued in 1826, but were discontinued in 1846 in favour of the *Quarterly Journal*, commenced in 1845 and now in its 113th volume. The present "Abstract of Proceedings", issued after each meeting, is a slightly modified form of the Abstracts first circulated to Fellows in 1857. The Society is now about to start a new publication of *Memoirs*. This new venture has been made possible by a generous bequest under the will of the late Henry Woods.

Meetings at which the results of geological research have been communicated and discussed have been, and still are, the most important activity of the Society. The earliest meetings of the Society were held at the Freemasons' Tavern, the members dining together before the meeting. Rooms were rented successively in Garden Court, Temple, and Lincoln's Inn Fields; but it was not until 1816, when rooms were taken at 20 Bedford Street, that a suitable meeting room became available. In 1828, apartments at Somerset House were granted to the Society, and there the Society remained until the move to its present rooms in Burlington House in 1874.

The practice of members dining together before the meeting continued for some years, and in 1824 the Geological Society Club was formed as a dining club limited to forty members. This Club still continues, but the hour of the Society's meeting was changed in 1915 from 8 to 5 o'clock; so the Club now dines after the meeting instead of before.

The centenary of the Society in 1907 was celebrated with great ceremony, and its proceedings are recorded in the centenary volume published in 1909. In preparation for the centenary, a history of the Society was written by Horace B. Woodward. There the real history of the first hundred years of the Society is told, and in it is recorded how the meetings of the Society have witnessed the gradual growth of the whole of geology from its beginnings. It is difficult in a few words to give any adequate account of the contributions Fellows of the Society have made to their science in the past fifty years, and what follows is the merest sketch.

One can recall now classic papers on the structure of the Highlands, cauldron subsidences and ring intrusions with their accompanying cone-sheets and dyke-swarms; great papers on the Lake District, and on glaciation; the geology of almost the whole of Wales worked out by perhaps a dozen different authors. In palæontology one recalls the papers on ammonites and the detailed zoning of the Jurassic; non-marine lamellibranchs and zoning of the Coal Measures; the flora of the Kent Coalfield; the analysis of the Pliocene flora based on the study of fossil seeds, and the later technique of pollen analysis.

Memorable papers dealing with metamorphic and volcanic rocks have greatly advanced our knowledge

of these branches of petrography; and discussions on differentiation, assimilation and the more recently advanced theories on the formation of granite may have been almost as animated as some of the early discussions of the previous century.

Wegener's theory of continental drift was the subject of a discussion in 1935; rostro-carinate flints and eoliths was another subject discussed before a large audience; and, one must admit it, the most crowded of all the meetings were those in 1912 and 1913 when fragments of the Piltdown skull and the broken lower mandible and canine tooth were described.

New techniques have been introduced to the Society both as papers and as exhibits. The use of cellulose films in the study of plant remains, applicable also to graptolites and corals, in 1923 and again in 1928; the use of polarized light for the study of the minute structure of foraminifera was demonstrated in 1920; and still earlier (1917–18) the use of X-rays for a similar purpose. Another war-time paper read in February 1915 was on radioactive methods of determining geological time, and a great meeting in 1923 was Joly's lecture on the bearing of some recent advances in physical science on geology; a development from his much earlier published book, "Radioactivity and Geology".

In the early days of the Society the main interest of its members was in minerals and mines, but they soon turned their attention to the wider fields of geology and to stratigraphy. The charge that the Society has too much neglected the economic applications of geology has perhaps been justified, but there is ample evidence now of its active interest in the practical problems of the day. A lecture and papers on oil in Britain, and a discussion in 1933 on the falling water-level in the Chalk under London, attracted crowded audiences. Many papers have dealt with the constitution of coal and the structure and zoning of the coal measures, and recent methods of geophysical survey and results that have been deduced from them have been the subject of several papers in the past ten years.

There are plenty of papers and material for interesting lectures, and the lecture room at Burlington House is often crowded to capacity. The problem that faces the Society is certainly not a lack of new fields of inquiry but rather perhaps how to extend its scope and bring to the Fellows more papers on the geology of other lands. The more material needs are: space for its audience, shelves for its books, and money for its printing. Reluctantly it has at last had to raise the annual subscription to meet the rising costs. Financing printing is, however, only half the solution; the remaining problem is the ever-present one of how to persuade authors not to write until their work is as complete as they can make it, and, when they write, to aim at brevity as well as clearness in expression and condensed presentation of essential details. This was the plea of three successive presidents in the 'eighties. It is still the plea of the Society to-day.

The 150th anniversary of the foundation of the Society was celebrated on November 13, 1957, and was marked by an afternoon meeting at which the president, Dr. Leonard Hawkes, gave a brief address, followed by the thirteenth William Smith Lecture, given by Prof. C. E. Tilley. A conversazione was held in the evening in the rooms of the Royal Society and in the Geological Society's apartments. Exhibits arranged by Fellows, many university geology departments, oil companies, the Geological Survey of Great Britain, and the overseas Geological Surveys, illustrated recent progress in geology.

NUTRITIVE VALUE OF PROTEINS

THE 112th meeting of the Nutrition Society was held on October 12 at the Royal Free Hospital School of Medicine, London, and took the form of a symposium on "The Nutritive Value of Proteins", with Dr. D. P. Cuthbertson, director of the Rowett Research Institute, Aberdeenshire, in the chair.

In his opening remarks, the chairman first pointed out that the quality and quantity of our protein needs are ever present in our daily speculations of what we shall eat and wherewithal we shall be clothed, and these in turn are largely governed by the kind of food our farm animals eat. The quality of the protein in the concentrated part of the diet or ration can in some cases be enhanced by proper processing, but it is sometimes damaged. Britain's annual imports of animal protein feeding stuffs amount to 1,048,000 tons and cost £38,129,000 a year, and a considerable saving on this could be effected by avoiding damage to the nutritive value not only of these imports but also of home-produced concentrates during processing and storage, and by their proper use to balance the ration.

The problems of protein quality and quantity for animals, including man, are of importance not only to the United Kingdom as one of the world's largest importers, but also to such bodies as the Food and Agriculture and World Health Organizations. For these need to know the nature and amount of the protein-rich supplements—milk, fish, soya-bean, groundnut preparations and so on—which should be added to a basic cereal or starchy diets in order to prevent protein malnutrition and to achieve some minimum standard of adequacy.

Dr. Kathleen Henry (National Institute for Research in Dairying), in a joint paper with Dr. S. K. Kon on "The Nutritive Value of Proteins: General Considerations", pointed out that earlier concepts of nutrition divided proteins into those of first- and those of second-class quality, the former being of animal and the latter of vegetable origin. With increasing knowledge it became evident that the differences between foods as protein sources reflect differences in amino-acid composition and also that the superiority of 'first class' protein is often partly due to accompanying vitamins. We know that the distinction between animal and vegetable proteins is neither rigid nor always justified.

The value of a food as a source of protein is determined by the concentration of protein in it, the digestibility of the protein, the availability of its amino-acids for the synthesis of tissue protein, and its amino-acid pattern, particularly the content and

proportions of the essential amino-acids. Digestibility and amino-acid pattern in turn determine the value of the food protein to the animal. There exist now many biological methods of assessing a protein on this basis, most of which compound these variables into one numerical expression. All are designed for, and capable of, assigning to a protein a relative order of nutritional merit and thus all can be considered as measuring its biological value.

Normally, proteins are considered in relation to their ability to promote growth or repair of body tissues or both. A protein that may be adequate for repair and maintenance in an adult animal may be less satisfactory for the combined functions of growth and repair in the young. Furthermore, the value of a protein for certain functions, such as replacement and building of specific plasma proteins, hæmoglobin and enzymes, may be quite different from that for the repair of body tissues as a whole.

Dr. Henry then dealt with the amino-acids essential for different species and at different ages, and the need both to secure that the amino-acids are present in the correct proportion, and to satisfy the energy requirements for maximum utilization of protein. She also dealt with mixed diets, the supplementary effect of proteins and the timing of their administration. It was stressed that the assessment of quality from amino-acid composition requires confirmation from feeding experiments. The effects of heat treatment were considered briefly in relation to culinary needs, elimination of toxic effects and preservation.

"Biological Methods of evaluating Protein Quality" was the topic of a paper by Dr. A. E. Bender (Bovril, Ltd.). He stressed the need to realize the nature of the conventional tests for protein quality and to appreciate the significance of the results derived from them. He dealt first with the methods of assay: the screening tests to give approximate grading, the protein efficiency ratio for growth, the net protein retention, the rat-repletion method and the microbiological technique. Next, Dr. Bender dealt with quantitative measurements, the Thomas–Mitchell method which measures the percentage of the absorbed nitrogen retained in the body and is termed the 'biological value', the 'nitrogen-balance index' introduced partly to avoid measuring endogenous excretion required in the preceding method, the carcase-nitrogen method which may involve only a simple water determination, the 'egg-replacement value' used mainly in human experiments, and growth and nitrogen balance methods. Various indirect methods were also outlined.

What is often required, however, is an experimental version of a field test, and here the gross protein value test has proved very useful. The diet is based on the normal practical diet of cereal, fed at 8 per cent protein-level, supplemented with 3 per cent test protein. The diet thus simulates husbandry conditions in which a knowledge of the nutritive value of the combination is required rather than the biological value of the concentrate alone. The gross protein value is the extra growth produced (beyond that on the control ration) divided by the supplementary protein eaten in a two-week experiment.

All measures of protein quality are essentially a function of the limiting amino-acid: the tests yield no information about the other amino-acids. The 'biological value' or the 'protein efficiency ratio' are not complete descriptions of a protein, since it is possible to find two proteins with the same biological value but with differing amounts of the non-limiting essential amino-acids.

Dr. K. J. Carpenter (School of Agriculture, Cambridge) then dealt with "Chemical Methods of evaluating Protein Quality". He stressed the impossibility of devising a single test (chemical or biological) that will give the answer for all circumstances. Analysis for amino-acids takes too much time and gives no information about digestibility or availability. A number of quick laboratory tests have been developed for foods to answer the needs of specific industries.

Of the cereals, only maize has been shown to be of variable protein quality, and that appears to be inversely related to the nitrogen content. Baking has little effect on quality, but the processing of breakfast foods may be deleterious.

Taking soya-bean oil meal as the principal example of the oil-seed meals, Dr. Carpenter pointed out that it requires some heating to destroy a trypsin inhibitor and so attain maximum value. The destruction runs parallel to, and may be followed by, the fall in urease activity. Heating beyond this maximum damages protein quality. Solubility tests carried out directly on the meal will give a measure of this damage; they are not effective with enzymic digests prepared from the meal. The enzymic release of specific amino-acids (estimated microbiologically) points to the 'locking-up' of lysine in overheated samples. Formol-titration similarly reflects damage by following the reduction of free ε-NH_2 groups, particularly that of lysine. In cotton-seed meal, quality control is complicated by the toxicity of the gossypol present and its apparent interaction with protein quality.

Animal products used in animal nutrition—fish and meat meals—present special difficulties because, in addition to changes induced by varying processing, the amino-acid composition of the raw material may vary considerably.

Animal products are rated highly because of their high concentration of nutritionally available lysine. As for the oil-seed meals, heat damage reduces the availability of the lysine. On the hypothesis that lysine is nutritionally available only when its terminal NH_2-group is free, a recently developed method measures 'available lysine' as the dinitrofluorobenzene derivative. The results obtained with a series of fish, whale and meat products have shown a close correlation with corresponding results from chick-feeding tests under conditions that emphasize the lysine contribution of the test materials.

The sulphur amino-acids are possible alternatives to lysine as the limiting amino-acids. Dr. Carpenter hoped that processing damage to lysine and cystine (more susceptible than methionine) might be roughly parallel, though the presence or absence of oxygen may upset this.

Dried milk, the product of a very even raw material, is exceptionally subject to processing damage; the dinitrofluorobenzene method and microbiological assay of an enzymic digest gave parallel rating of quality. For the evaluation of mixed diets this latter method was thought to be the most effective.

"The Importance of Protein Quality in Animal Feeding" was described by Dr. Gabrielle Ellinger (Rowett Research Institute). Economy in the use of protein may be exercised by the correct allocation of concentrates to practical rations, and by the conservation of quality during the production of concentrates.

Currently, practical rations for non-ruminants are compounded to contain protein in excess of requirement to compensate for the fluctuations in the quantity and quality of protein in available feeding stuffs.

To have practical significance, the evaluation of concentrates must be for their capacity as supplementary protein. The cereals, used principally as sources of energy for fowls, contribute 40–65 per cent of the total protein in some practical rations according to the classes of poultry concerned. Similarly, in pig rations 50–70 per cent of the protein is derived from cereals according to the proportion of millers' offals and bran included. Related to the chick's and pig's requirements for the essential amino-acids, the proteins of wheat, barley, oats and maize are deficient mainly in lysine and rather less deficient in the sulphur amino-acids. Maize is also deficient in tryptophan. No processing damage is involved, although feeding quality of maize is known to vary with variety and fertilizer treatment.

Beyond the quantitative supplementation of the cereal proteins, therefore, concentrates must compensate for the failure of cereal proteins to contribute their share of the essential amino-acids. The concentrates that are offered as feeding stuffs may be derived from a wide range of raw materials and differ greatly in their amino-acid composition. Processing damage introduces further variations in the protein quality of any given concentrate. Lysine and the sulphur amino-acids are not only the acids most subject to damage but also, being the limiting amino-acids in the cereals, their concentration largely determines the supplementary value of the concentrates.

The critical level of protein in the test rations must be considered in relation to the energy content. The highest critical level of protein at which additions bring no improvements and reductions a fall in production is in itself a measure of protein quality, and has been used for grading certain concentrates as supplements in pig rations. Alternatively, in the gross protein value experiments, concentrates fed at a constant and very low level of protein contribution and compared with standard protein have been effectively graded according to the heat damage sustained. A concentrate fed for its contribution of a particular amino-acid may be evaluated in terms of the availability of that acid.

Prof. B. S. Platt and Mr. D. S. Miller (Human Nutrition Unit, Medical Research Council), in their paper on "The Quantity and Quality of Protein for Human Nutrition", reviewed some of the findings of earlier workers in this field which are too frequently neglected. They also directed attention to the more recent Princeton Conference on Human Protein Requirements and their Fulfilment in Practice and to Terroine's emphasis on the distinction between physiological requirement—the minimum amount of protein required to maintain nitrogen balance—and the hygienic requirement—the amount needed under the stresses of everyday life.

Many of the difficulties of prescribing a diet for the human subject are concerned with (*a*) the complexity of the mixtures eaten by man; (*b*) the nature and timing of snacks and meals; (*c*) the effect on food values of a wide variety of methods of processing, including cooking; (*d*) the level in the diet, not only of protein but also of other sources of energy—fats and carbohydrates—and of various vitamins and minerals; and (*e*) the balance between the proteins and several other dietary factors. In some human dietaries, better protein utilization might be achieved by providing additional amounts of either fat or carbohydrate or both, thereby not only preventing wasteful burning of protein but also inducing a protein-sparing action. We do not know whether the pattern of amino-acid requirements is the same for maintenance as for growth of the young or, therefore, whether there are additional needs of the mother during pregnancy and lactation. However, the validity of the methods for the determination of the physiological requirement of an individual for a specified protein or for the essential amino-acids is fairly well established, although it is still not understood, for example, (*a*) why in Rose's experiments it was necessary to have such a high calorie intake; (*b*) why the ratio of infant to adult requirements per kilogram of body weight is so much higher when expressed in terms of essential amino-acids (about 10 : 1 for most amino-acids) as compared with the ratio in terms of reference protein (about 5 : 1); (*c*) what the composition and amount in a diet of nitrogenous matter other than the essential amino-acid nitrogen should be; and (*d*) what determines the variations in physiological minima for nitrogen for different individuals. The importance of zymotic factors in the production of protein malnutrition has not yet been fully appreciated.

Possibly for maize and most certainly for cassava pap, the volume of the infant stomach must be a limiting factor in adequate protein nutrition of the young child. The necessity in these circumstances of providing food rich in protein is clear; this may be most conveniently and desirably provided as human milk, but where the diet is low in protein the problem of extra supplies of good protein is simply shifted to the mother who can, however, utilize cruder sources of supply than can the young child.

The final paper of the session was on "Nitrogen Balance following Injuries" by Dr. J. P. Bull (Medical Research Council, Industrial Injuries and Burns Research Unit, Birmingham). Dr. Bull pointed out that the circumstances, nature and timing of injury and the corrective procedures are sufficiently different to make one cautious in accepting an operation as a very close analogy to accidental trauma. In the latter Dr. Bull considered that the overall nitrogen balance is not entirely informative when one considers losses of whole protein, as in exudate or hæmorrhage and transfusions of similar materials on the same basis as oral feeding and urinary and fæcal losses. There is no possibility of an initial stabilizing period in accident cases, and the previous nutritional status cannot be known with precision. In the more severe injuries, therapy must necessarily be varied to meet individual requirements; nutrition is only one of these, and must be changed to permit other procedures.

It has been shown that intravenous plasma protein is only slowly metabolized, and if nitrogen is so given in excess it will be excreted in the urine only after several days. Correspondingly, after transfusion of red cells, excretion of excess nitrogen is even longer delayed. Furthermore, if there has been loss of plasma, as from a burn, or loss of blood from other injuries, intravenous replacement may be virtually direct, so that neither the loss nor the transfusion should appear in the nitrogen balance on the same basis as oral and urinary exchange. Even the quantities accepted for calculation are suspect; digestion and absorption of orally fed protein may well be disturbed in the severely injured patient, and renal

excretion of nitrogen is frequently depressed. When one considers the details of the balance sheet within the body, the situation is clearly more complex again. Whatever the overall balance may be, the internal economy of nitrogen is grossly deranged, as shown by changes in plasma proteins.

There appears to be a general increase of catabolism, possibly combined with a diminished anabolism of protein in which adrenocorticotrophin and adrenal cortical hormones may well be playing a part. Prior depletion of protein prevents the increased excretion of nitrogen after injury. It thus seems likely that the more labile protein stores are first used, and when these are exhausted further tissue protein is not raided.

Dr. Bull reported a comparison of nitrogen input with renal nitrogen output in patients who had been adequately treated by transfusion, and found little difficulty in obtaining 'apparent positive' nitrogen balances. Though this clearly does not represent the whole story, it should be remembered that comparison of intake with renal output is the main ground for claims that the 'catabolic phase' makes negative balances obligatory. From this point of view exudate losses should not necessarily be included, since they do not represent catabolism but rather loss of part of an organ equivalent perhaps to an amputation or plasmaphoresis.

Dr. Bull considered that, in the present state of knowledge, the following principles seem rational: (1) Where there are known losses of blood proteins, these should be replaced by transfusion. Plasma and blood are the rational replacement fluids for burns, and blood transfusion for other injuries. Recent studies show that these losses are greater than has previously been assumed, and we are probably only now beginning to obtain adequate correction. (2) Generous protein and calorie supplies should be available for the injured patient in his diet. Many ordinary hospital diets are inadequate in this respect. (3) There is no practical limit to the amount of nitrogen which can be given, either intravenously as hydrolysate or amino-acid mixtures or as oral high-protein tube feeds. It is rational to minimize the loss of nitrogen and to anticipate the subsequent strongly anabolic phase of healing by supplements to ordinary feeding. Inputs of the order of 0·5–1 gm. of nitrogen/kgm. per day and 40–60 Cal./kgm. can be given to the more severely injured patients. (4) In the severely injured patient a multitude of complex processes are at work, and it is presumptuous to expect them to be explained under any single simple theory.

In winding up the symposium, the chairman said that there had been brought to light the need for a clearer definition of terms and a more thorough appreciation of the older literature, which is liable to be forgotten or ignored; that chemical analyses, though useful guides, are not enough by themselves and that the product must, in general, always be tested biologically in the way it will be used; and that there are problems of quality in protein nutrition of man in health, when injured or diseased, that warrant much further study. D. P. Cuthbertson

RETINAL SUMMATION AND HUMAN VISUAL THRESHOLDS

By Dr. R. A. WEALE

Visual Research Division, Ophthalmological Research Unit, Medical Research Council, Institute of Ophthalmology, London, W.C.1

ONE of the mainstays of the duplicity theory of vision is the observation that the centre of the human fovea, which contains only cones, is much less sensitive to light than the extra-foveal regions, dominated by rods. Even at the present time, numerous workers tacitly infer from this finding that, receptor for receptor, rods are very much more sensitive than cones. Observations on dark-adaptation have suggested that the ratio of the two sensitivities may amount to several hundred or even one thousand, and the photo-chemists' apparent inability to extract and characterize cone-pigments goes hand in hand with the view that the low cone-sensitivity is due to the low *in vivo* concentration of these pigments. The plausibility of such an explanation is probably responsible for the fact that experimental evidence not in support of the above views has failed to find acceptance. It may, therefore, be of interest to try to harmonize the two sets of observations and to establish a formal connexion between them.

Lythgoe[1], Stiles and Crawford[2], Craik and Vernon[3], Baumgardt[4] and others have suggested that the large value of the ratio extra-foveal sensitivity/foveal sensitivity may well be due to the good summating properties of the peripheral retinal regions. These would be revealed particularly when experiments are carried out with medium-sized or large test-fields. But as the fovea shows relatively poor summation, visual threshold tests with small fields both in foveal and extra-foveal regions would provide more comparable data than when the fields are large. There is no doubt that this expectation is strikingly fulfilled by experiment. Fig. 1 represents a plot of the logarithm of R_I, the ratio of foveal to extra-foveal thresholds, against the logarithm of A, the size of the test-field, measured in square minutes of arc. Corrections were applied to the measured values for light absorption by the macular pigment, and, where thresholds had been measured with white light, for the non-equality of the energy distribution of the stimulus. The former factor reduces cone thresholds for white light by approximately 0·1 log unit, the latter increases them by about 0·38 log unit. The resultant correction is small but tends to reduce the scatter of the results. The values of R_I were also calculated so as to refer to the maximum of the spectral sensitivities of dark-adapted foveal and extra-foveal regions, respectively. The letters refer to the authors, and are listed separately in the references. There is an approximately linear relation between R_I and A': extrapolation near the origin

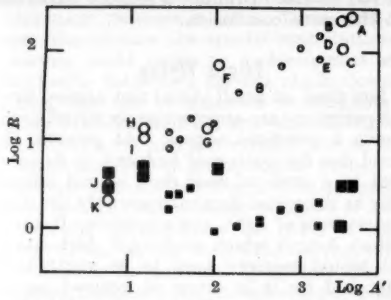


Fig. 1. Log ratio of foveal to extra-foveal thresholds in the dark-adapted human eye as a function of the test-area in log square minutes of arc. Circles: ratios expressed in terms of intensities. Squares: the corresponding values expressed in terms of the 'effective stimuli'. (The letters refer to authors listed in the references)

suggests that, for stimulus areas commensurate with the cross-sectional areas of the receptors involved, R_I approaches unity. This is to say that, when the summating properties of the retina have been eliminated, the sensitivities of rods and cones are approximately equal. Baumgardt[4] reached this conclusion readily from his own results. However, his approximate treatment of the values of R_I as observed with large values of A took no cognizance of retinal summation.

The Effective Stimulus

The concept of the effective quantity of light is of some help in this respect. It has previously been shown[5] to lead to a useful generalization of the Ferry–Porter law, and involves the rejection of light intensity as the almost exclusive factor in stimulus variation. The effective quantity Q is defined as

$$Q = I(AN)^{p}.t^{q} \qquad (1)$$

where A is the retinal area stimulated by light of intensity I and for a duration t; N is the relevant receptor density in the region stimulated, and p and q are the coefficients of spatial and temporal summation, respectively. In the following discussion t^q will be assumed to be constant. The importance of the concept of Q becomes apparent as soon as one considers an orthodox dark-adaptation curve: when a non-fixating human eye is exposed to light, and then left to dark-adapt, its threshold, as measured with, say, a 1°-field, drops rapidly at first, reaches a plateau after some 2–3 min., starts dropping quickly after another 5–7 min., and approaches its final threshold after another 20 min. The first plateau represents the threshold of the cones, the second that of the rods. Yet a consideration of the effective light stimulus Q shows that the two portions of the curve are not strictly comparable, because both N and p are different for rods and cones, respectively. The intensity I can provide a measure of the effective stimulus Q only when N and p are constant. The fact that p can change with time even when N is constant[2,3,7] renders exclusively photo-chemical interpretations of dark-adaptation untenable. Indeed, for a test-field of 1° angular diameter a temporal change in p of 0·5 (cf. ref. 6) accounts for a full two log units of dark-adaptation.

The idea of the effective stimulus is readily applied to the experimental results plotted in Fig. 1. It is then seen that:

$$\log R_Q = \log \frac{Q_c}{Q_r} = \log R_I + (p_c - p_r)\log A + p_c \log N_c - p_r \log N_r \qquad (2)$$

where the suffixes r and c refer to rods and cones, respectively. The data for N_c and N_r (at eccentricities ranging from 0 to 20°) were obtained from Østerberg's[8] counts. Baumgardt[9] has determined the variation of p_c with A; these findings were confirmed and supplemented by Brindley[10]. Baumgardt also showed that, at an eccentricity of 15°, p_r is 1 for A less than 1·3°. As it was not permissible to assume that this would be true also at smaller eccentricities (and, in a relevant experiment, Wolf and Zigler[11] had altered retinal eccentricity while altering the size of the test field), additional measurements were made with a Crookes adaptometer. The region examined was 8° above the right fovea, where Wald[12] carried out his peripheral measurements. The observer, R. A. W., was dark-adapted for 35 min., without having previously been exposed to bright light. Five test-fields, ranging in angular diameter from 0·60° to 1·45°, were presented in a random manner in three different sessions. The stimulus, modified by an Ilford 624 (green) 'Bright Spectrum' filter, was exposed for 1/25 sec., and the threshold criterion was two 'seen' out of three exposures, presented in rapid succession. The results are shown in Fig. 2: the lines, reproduced from Baumgardt[9], are consistent with these results. It would appear that even with a 1° test-field, applied relatively closely to the fovea, rod summation is found to differ from that observed for cones. The values R_Q, calculated from equation 2, are shown as black squares in Fig. 1 and correspond to the values R_I plotted as white or small semi-white circles, from which they have been derived.

Two features are outstanding: first, R_Q is approximately independent of A, the size of the test-field, and secondly, it is of the order of unity. This suggests that, when allowance is made for regional differences in receptor density and for the different summating properties of the dark-adapted fovea and periphery, respectively, rod and cone thresholds are approximately equal. This is true even when they are measured with a test-field so large as to cover the whole of the rod-free area.

The above calculation has involved two simplifying assumptions, both of which tend to make the calculated values R_Q too large. The cone density N_c

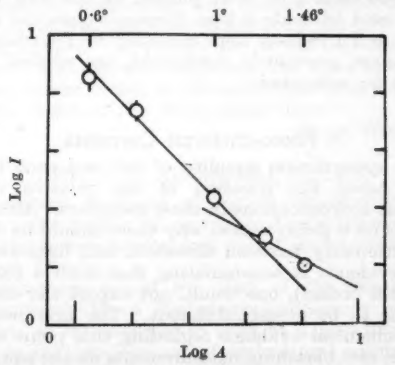


Fig. 2. Log threshold intensity (arbitrary units) as a function of the log test-field (arbitrary units). The angular diameters of the test-fields are shown at the top. Standard errors of the mean are indicated. The lines are reproduced from Baumgardt's data (ref. 9). For details see text

was taken to refer to all cones. If it is assumed tentatively that the number of 'green sensitive' cones forms only half to a third of the total, the log R_Q values corresponding to small values of A will be reduced by 0·3–0·5 and those referring to larger test-fields by not more than about 0·2. Again, the value of N_e was assumed to be constant throughout the rod-free area of the fovea. The removal of this assumption would reduce the log R_Q values for log A greater than 2·6 by less than 0·2. Owing to some uncertainty regarding the exact variation of foveal summation with area for very small areas, the R_Q values for larger test-fields are certainly the more reliable of the two. The additional corrections lead, therefore, to log R_Q values equal to, or less than, zero.

There is no need to labour the point, beyond stating that a single cone may well be as sensitive as a single rod, if not more so. It would be a bold man, indeed, who would introduce into the argument morphological differences between the two types of receptor. Cones are sometimes said to have special light-funnelling properties; human foveal cones, however, have a more rod-like appearance than the rods themselves, and one can scarcely even speculate on funnelling in a vessel the dimensions of which are comparable with the wave-length of light, and the optical properties of which are virtually unknown.

The analysis shown in Fig. 1 contains all the relevant results known to me with but three exceptions: first, Riezler, Esper and Meurers's[13], who failed to immobilize the observers' heads to an extent which is generally considered a minimum requirement (cf. also ref. 14); secondly, Craik and Vernon's[3], whose R_I value is shown in Fig. 1, but who do not seem to have specified the retinal eccentricity at which the rod portion of their results was obtained; and thirdly, Pirenne's[15], which raise a point of great interest. Using a blue test-field at 10′ angular diameter, he measured the absolute threshold in the fovea and at various eccentric locations up to 4°. Now Brindley[16] has shown that p_e equals 1 for blue test-fields as large as 13′ in diameter, whereas p_e equals 0·5 for smaller test-fields, red or green in colour. Clearly, an attempt to express a foveal threshold measured with a blue 10′-field in terms of the maximal foveal sensitivity (yellow-green) leads to an inadmissible situation, analogous to the one illustrated earlier by reference to the dark-adaption curve. As the relative number of 'blue' receptors in the fovea cannot be even guessed at, the only point which need be made is that Pirenne's observed value log $R_I \approx 2{\cdot}1$ reduces approximately to 1·1 when the corrections, previously mentioned, are applied. R_Q cannot be estimated.

A Photo-chemical Correlate

The approximate equality of rod and cone thresholds raises the question of the relative visual pigment concentrations in these receptors. Although there is no *a priori* reason why there should be direct proportionality between threshold and light-absorption (evidence is accumulating that such a relation need not obtain), one would not expect the concentrations to be greatly different. The first piece of photo-chemical evidence regarding this point comes from *in vivo* bleaching measurements on the squirrel's pure-cone retina[16]; it shows that the visual pigment density changes on bleaching by an amount commensurate with that found in experiments carried out on rod-retinæ. Brindley's sensory experiments[17] lead to the same conclusion.

Night Flying

The fact that, at small visual test-angles, the fovea and the periphery are approximately equally sensitive may have a practical sequel. At present, Service personnel due for nocturnal look-out or flying duties are kept in a state of near dark or red adaptation. In so far as the visual demands are only the detection of point sources of light, the sensitivity factor of not more than 5 or 6 which prolonged dark-adaptation bestows would scarcely seem to be worth the price possibly paid for it in terms of reduced morale. If the visual task involves the detection of 'dark shapes on the horizon', prolonged dark-adaptation is unavoidable. But when the object is the detection of point sources, dark-adaptation of a few minutes may well be adequate. Stars appear, after all, little brighter after 50 min. than after 5 min. spent in the dark.

Note added in proof. Since this paper was submitted for publication, Pinegin[18] has shown that, for very small test-fields, rod and cone thresholds are comparable in magnitude.

[1] Lythgoe, R. J., *Brit. J. Ophthal.*, **24**, 21 (1940).
[2] Stiles, W. S., and Crawford, B. H., *Proc. Roy. Soc.*, B, **122**, 255 (1937). [H] observer W. S. S.; [I] observer B. H. C.
[3] Craik, K. J. W., and Vernon, M. D., *Brit. J. Psychol.*, **32**, 62 (1941). [G].
[4] Baumgardt, E., *C.R. Soc. Biol.*, **143**, 786 (1949). [D] observer E. B.; [E] observer H. W.
[5] Weale, R. A., *J. Physiol.*, **137**, 50*P* (1957).
[6] Arden, G. B., and Weale, R. A., *J. Physiol.*, **125**, 417 (1954). [J] observer G. B. A.; [K] observer R. A. W.
[7] Best, W., *Acta Ophthal.* (*Kbh.*), **31**, 95 (1953).
[8] Østerberg, G., *Acta Ophthal.* (*Kbh.*), Supp. 6 (1935).
[9] Baumgardt, E., *Rev. Opt.*, **28**, 661 (1949).
[10] Brindley, G. S., *J. Physiol.*, **124**, 400 (1954).
[11] Wolf, E., and Zigler, M. J., *J. Opt. Soc. Amer.*, **40**, 211 (1950).
[12] Wald, G., *Science*, **101**, 653 (1945). [B].
[13] Riezler, W., Esper, F., and Meurers, H., *J. Phys.*, **137**, 238 (1954).
[14] Weale, R. A., *Physiol. Rev.*, **35**, 233 (1955).
[15] Pirenne, M. H., *Nature*, **154**, 741 (1944).
[16] Weale, R. A., *J. Physiol.*, **127**, 587 (1955).
[17] Brindley, G. S., *J. Physiol.*, **122**, 332 (1953).
[18] Pinegin, N. I., Symp. Visual Problems of Colour, Paper No. 33 (National Physical Laboratory, Teddington, 1957).

Sloan, L. L., *Amer. J. Ophthal.*, **33**, 1077 (1950). [C].
Stiles, W. S., quoted in *Ned. T. Natuurk.*, **15**, 125 (1949). [A].
Bouman, M. A., *Docum. Ophthal.*, **4**, 23 (1950). [F].

OBITUARIES

Dr. O. G. S. Crawford, C.B.E., F.B.A.

O. G. S. Crawford, who died on November 28, 1957, was one of the best-known British archæologists of his generation. Born in India in 1886, educated at Marlborough and Keble College, Oxford, where he turned from classics to geography, he soon began to make original contributions to archæology. He was impressed with the importance of studying the environment of early man, and the influence of geographical factors upon human affairs, ideas which found expression in his first book, "Man and his Past" (1921). His interests led him to undertake an archæological survey of an area near his home, which was published in 1922 as "The Andover District", and is still well worth reading. In 1913 he joined the Wellcome expedition to the Sudan, but this opportunity was cut short by the outbreak of the First World War. After a period in the infantry, he joined

the Royal Flying Corps as an observer, being shot down and taken prisoner in 1918. There were few at that time who foresaw the special contributions that aerial survey could make to archæological studies, but Crawford's field-work on the chalk downs had shown him the use of shadows in studying complicated earthworks, and his war-time flying experience impressed upon him the value of the aerial view for the understanding of archæological sites.

At the time of the First World War archæological posts were few and offered little prospect of a career, but Crawford's appointment in 1920, as the first archæology officer at the Ordnance Survey, provided just the opening he needed. Until the time of his appointment, the archæological information embodied in Ordnance maps was largely in the hands of the field staff, who might have little knowledge of archæology, no matter how competent they were at surveying. The task confronting Crawford was immense; however, he found time not only for routine revision of archæological detail on the Ordnance maps, but also for the preparation of a series of 'period' maps, of which that of Roman Britain was the first and best known. The value of this work at the Ordnance Survey, undertaken with a minimum of assistance, may be seen in the official large-scale maps of the United Kingdom, which attain a standard in archæological cartography scarcely approached elsewhere. The results of Crawford's field surveys were published as individual papers or larger works, such as "The Long Barrows of the Cotswolds" (1925), an important account of a selected class of monuments.

It is probably as the pioneer of archæological air photography and as the founder-editor of the quarterly journal *Antiquity* that Crawford will best be remembered. His achievement in the first sphere culminated in the publication, with Alexander Keiller, of "Wessex from the Air" (1928), a splendidly illustrated account of an archæological air reconnaissance of Salisbury Plain and adjacent areas, which sets a new standard in archæological research. In 1928, Crawford visited the Middle East, in an attempt to secure the preservation of air photographs taken by the Royal Air Force, and to direct attention to the unique possibilities open to air photography for research in that region. He was ever keen to foster the development of the subject in Britain, either publishing discoveries himself or making known the work of others in the same field. Much of his later work appeared in *Antiquity*, over which he took great pains, making several special journeys to Europe and North Africa. If the first dozen years of that journal represent its best period, it has always provided a forum for review and criticism and for exchange of ideas on all branches of archæology.

As an archæologist Crawford had a flair for field survey, which served him well when studying earthworks, either on the ground or from the air. He was a marked individualist, gifted with considerable powers of expression, to which the pages of *Antiquity* bear witness. For such a person, relations in an official department cannot always have been easy, but he had a great capacity for friendship, and was able to awake in others something of his own immense enthusiasm for his chosen subject. He was created C.B.E. in 1950, elected Fellow of the British Academy in 1949 and awarded honorary degrees by the Universities of Cambridge and Southampton.

J. K. S. St. Joseph

Prof. W. J. Jongmans

The sudden death of Prof. Jongmans, at Heerlen on October 13, robs the world of one of its most active palæobotanists. Willem Josephus Jongmans was born on August 13, 1878, at Leyden, where he received his early education. A student of the University of Leyden and later of the University of Munich, he was awarded a D.Phil. of the latter University in 1906. In the same year he was charged with palæobotanical research in one of the Dutch Government Services concerned with fuel resources, and the following year, 1907, was appointed a curator at the Rijksherbarium in Leyden. In 1919 he was released from the post at the Herbarium to become head of one of the departments in the Government Geological Service. While holding this position Jongmans was nominated head of the office at Heerlen, which led directly to his appointment as director of the Geological Bureau of the Netherlands Mining District at Heerlen, a post which he held from 1924 until his retirement in 1946. In addition to being director of the Bureau he was, from 1932 onwards, extraordinary professor of palæophytology in the University of Groningen.

Throughout his career, Jongmans's interest was directed towards the study of the flora of the Carboniferous period, and his extensive knowledge led to the publication of many authoritative papers on the plants from such widely distant places as Limburg and Sumatra, North America and Anatolia, Peru and Egypt, Spain and the U.S.S.R. But perhaps he is best remembered in Britain for the excellent "Monograph of the Calamites of Western Europe", written in collaboration with Kidston (1915–17), and the monumental "Fossilium Catalogus", published in twenty-two parts between 1913 and 1937. Jongmans's interest was not, however, confined purely to the plants, but extended over the floral assemblages of which they had been members. Early in his life he made a specialist study of the stratigraphic relations of the Carboniferous floras and he was responsible for many publications on this aspect of palæobotany. We should remember also his very important opinions on the nomenclature of fossil plants.

Though he officially retired in 1946, Jongmans carried on active research until the very last, and he was often to be seen in the Geological Bureau, which was only a short distance from his home at Heerlen. Time was always found to welcome and encourage a visiting palæobotanist who had come to see the magnificent collections and discuss problems with the master who had done so much for the furtherance of his subject. In recognition of his services to his country and science, Jongmans had been elected an Officer in the Order of Orange-Nassau and a Knight of the Order of the Netherlands Lion.

Alan Wesley

Mr. C. T. Gimingham, O.B.E.

Through the death of Conrad Theodore Gimingham on November 16, agricultural entomologists and plant pathologists have lost one of their pioneers and dearest friends.

Gimingham joined the staff of the Ministry of Agriculture's Plant Pathology Laboratory at Harpenden, as entomologist in 1928, at a most important time in the development of agricultural entomology. The specialist biological advisory services in agriculture had started some years earlier when several young and enthusiastic biologists were stationed at

universities and agricultural colleges to investigate local problems and give advice to farmers. The Plant Pathology Laboratory acted as their co-ordinating link, and Gimingham came into very close touch with all the advisory entomologists. In 1944 he succeeded the late Sir John Fryer as director of the Laboratory and as chairman of the Conference of Advisory Entomologists, with which he had been closely associated since his appointment. It was one of his great delights, and although he relinquished his chairmanship shortly after his retirement, he remained a member until his death. The modern developments in the insecticide field, with which Gimingham had much to do, started in the 1920's, and he proved to be an ideal person to guide the biologists who had become available, to see that the best use was made of the new materials provided by research and industry.

In the late 1930's it became evident that there was a real need to institute some form of approval scheme for crop-protection chemicals. It was largely through Gimingham's ability for painstaking negotiation and the deep respect in which he was held by both sides that in 1942 the Ministry and the Association of British Insecticide Manufacturers instituted the voluntary Crop Protection Products Approval Scheme. The success of this venture bears testimony to his achievement.

He was deeply occupied in phytosanitary work at home and in Europe, for example, with the Colorado beetle, and he must be given a good deal of the credit for preventing this pest from becoming established in Great Britain after the Second World War.

Perhaps Gimingham's greatest influence lay in his keen interest in the development of the younger entomologists. His quiet modesty, kindliness and sincerity made him the ideal guide, philosopher and friend. We were happy and privileged to place our trust in him, and many of us are thankful for his help.

Gimingham was closely associated with the Royal Entomological Society and the Association of Applied Biologists, of which he was president during 1938–40.

He married, in 1912, Muriel Blake, who survives him together with two sons and a daughter.

F. H. Jacob

NEWS and VIEWS

Rothamsted Experimental Station : Sir William Ogg

The retirement of Sir William G. Ogg from the directorship of the Rothamsted Experimental Station is announced to take place next September. He succeeded Sir John Russell in 1943, having previously been director of the Macaulay Institute for Soil Research, near Aberdeen. At Rothamsted he continued the expansion begun in the inter-war period, and successfully organized the inclusion of the Soil Survey of England and Wales previously directed by the late Prof. G. W. Robinson, of Bangor, bringing Dr. A. Muir from Aberdeen as the new head. As the owner and manager of a well-known farm in Aberdeenshire, Sir William has had exceptional opportunities of appreciating the new, and often difficult, agricultural problems of the post-war period and the ways in which modern science could contribute to their solution. His genial approachability has given him considerable popularity in agricultural circles, and on a variety of occasions he has been asked to undertake official visits overseas to advise on problems where his knowledge and shrewd judgment proved very helpful. His friendly relations with the Rothamsted staff enabled the expansion of the various departments to proceed smoothly, and when the Station finally obtained vacant possession of the attractive old manor house, which had been acquired with the estate in 1934, he had it converted into a hostel, thereby providing living quarters for some of the staff, as well as additional accommodation for conferences and other gatherings. His useful term as president of the Society of Chemical Industry will long be remembered. It is understood that he will retire to his farm, where all his friends and former colleagues will wish him and Lady Ogg many happy years of useful activity.

Mr. F. C. Bawden, F.R.S.

Mr. F. C. Bawden, head of the Plant Pathology Department of the Rothamsted Experimental Station, has been appointed director of the Station in succession to Sir William Ogg. Mr. Bawden, who is forty-nine, is well known for his brilliant researches on the virus diseases of plants, for which he was elected a Fellow of the Royal Society in 1949. His appointment shows the growing importance of plant pathology in Great Britain : the directorship has hitherto been from the side of soil and plant nutrition, the original, and for long the main, subject of the Rothamsted investigations. After a distinguished career at Cambridge, he went to Rothamsted in 1936 as physiologist to the Virus Disease Unit and soon attracted attention by identifying, in conjunction with his biochemical colleague, N. W. Pirie, a number of plant viruses and virus strains as nucleoproteins. They isolated in crystalline form the tomato bushy stunt virus, the first ever to be so obtained. With another colleague, A. Kleczkowski, much valuable work has been done on the serology of the viruses. New methods have been discovered of inactivating viruses without destroying their antigenicity. Mr. Bawden has also organized much valuable field work to discover the factors affecting the rate of spread of virus diseases, in the hope of finding measures of control. He has shown that he not only possesses high scientific ability and power of organization, but also that he can appreciate scientific merit in others. Under his direction, Rothamsted may confidently be expected to maintain the high position it has hitherto held among the world's institutes for the development of agricultural science.

Ministry of Agriculture, Fisheries and Food ; Fishery Research : Mr. G. M. Graham, C.M.G., O.B.E.

The Ministry of Agriculture, Fisheries and Food has announced the retirement on February 21 of Mr. G. M. Graham, director of Fishery Research. Mr. Graham has served on the Ministry's staff for thirty-eight years, having joined the staff of the Lowestoft laboratory in 1920. In his earlier years, Mr. Graham was especially concerned with research

on the cod, and his work laid the foundations for our knowledge of that species in the North Sea. In 1927 he was loaned to the Government of Kenya to survey the fisheries of Lake Victoria; and in 1931 he was loaned to the Biological Board of Canada to study the herring in Passamaquoddy Bay. He was Buckland professor for 1939. Mr. Graham served with the Royal Navy during the First World War, and during the Second World War he was with the Ministry of Aircraft Production in operational research and served with the honorary rank of wing commander in the European operations with the Royal Air Force. He was made O.B.E. (Mil.) in 1946.

On his appointment as director of fishery research in 1948, Mr. Graham turned himself enthusiastically to problems arising out of the War and to the development of modern fisheries investigation. He will be especially remembered for the encouragement and direction that he has given to the mathematical treatment of the study of fish populations. During his directorship the fisheries research staff has increased greatly in size, and the number of research ships was increased to include the *Ernest Holt*, which has carried the English investigations far into the north-east Arctic. A new laboratory for shell-fish investigations was also started at Burnham-on-Crouch under the leadership of Dr. H. A. Cole. In 1954 Mr. Graham was made C.M.G.

Mr. R. S. Wimpenny, O.B.E.

Mr. R. S. Wimpenny, who has been deputy director of fishery research at Lowestoft since 1948, has been appointed director of fishery research in succession to Mr. Graham. Mr. Wimpenny joined the staff at the Lowestoft laboratory in 1925 and was chiefly engaged on plankton research, in which he advanced our knowledge of the fat content of copepods, and the biology of diatoms. In 1927 he left the Ministry's staff to become director of fishery research to the Egyptian Government. While in Egypt he established a successful fishery for grey mullet in Lake Quaroun, the mullet fry being transported by air 100 miles inland from the sea. Mr. Wimpenny rejoined the Lowestoft staff in 1932 and resumed work on plankton. He has also done research on the plaice, which was the subject of his lectures as Buckland professor in 1949.

During the First World War Mr. Wimpenny served as a pilot in the Royal Flying Corps and, later, in the Royal Air Force. During the Second World War he was district inspector of fisheries for the eastern part of the south-east district of England and was Port Fishery Captain of Rye. Since the War he has been especially responsible for leading the work of the Lowestoft laboratory in research in the near fishing waters. He has also given much time to the work of the International Council for the Exploration of the Sea, and has been chairman of its Consultative Committee since 1951. Mr. Wimpenny was made O.B.E. in 1957.

Geological Society: Awards for 1958

The Council of the Geological Society of London has made the following awards for 1958: *Wollaston Medal:* to Prof. Pentti Eskola, doyen of Finnish geologists, distinguished for his contributions to metamorphic geology, especially in regard to the redistribution of material during metamorphism, the origin of granitic magmas and the conditions during the earliest geological time; *Murchison Medal:* to Dr. R. G. S. Hudson, for outstanding researches on the Carboniferous rocks of the north of England, in particular on their stratigraphy and palæontology; in recent years his work has been connected with the search for oil in the Middle East; *Lyell Medal:* to Dr. Helen Muir-Wood for her fundamental contributions to knowledge of the Brachiopoda; *Wollaston Fund:* jointly to Mr. R. J. A. Eckford for his work on the Geological Survey in connexion with the igneous rocks of Scotland and in particular his investigations of the geology of the Southern Uplands, and to Mr. W. Manson for his work on the Geological Survey in connexion with the stratigraphy and palæontology of the Scottish Carboniferous rocks; *Murchison Fund:* to Dr. Geoffrey Bond in recognition of his researches into the Carboniferous stratigraphy and palæontology of Britain, and the Karroo system and later deposits of southern Africa; a moiety of the *Lyell Fund* to Mr. H. R. Warman for his stratigraphic and tectonic work in Sicily and South Iran, and his contribution to oil and gas exploration in the United Kingdom; another moiety of the *Lyell Fund* to Dr. Eileen Lind Hendriks, in recognition of her researches on the geology of the Cornish peninsula.

Extension of Imperial Chemical Industries' Research Fellowship Scheme

Important changes have been made in the scheme of post-doctorate fellowships for research in chemistry, physics, engineering and related sciences offered by Imperial Chemical Industries, Ltd. Since the start of the scheme in 1944, Imperial Chemical Industries Fellowships have been tenable in a considerable number of British universities, but not in all. In future, the scheme will apply to all universities in the United Kingdom, to the University College of North Staffordshire and to Trinity College and University College, Dublin. The number of fellowships will be increased from 92 to 103. Individual fellowships will now range in value between £700 and £1,000 per annum, and the scheme is guaranteed for five years. As in the past, the universities and colleges will themselves make the appointments and draw up the regulations governing the holding of the fellowships. Imperial Chemical Industries exercises no control over the conduct of the research work. It is hoped that the scheme will help in promoting vigorous schools of research in British universities, and so contribute to the advancement of scientific knowledge upon which industrial progress ultimately depends. The enlarged scheme will cost approximately £93,000 per annum—a sum which, when added to other financial assistance given by Imperial Chemical Industries to universities and learned societies, raises the Company's total contribution to scientific education and research in Great Britain to more than £300,000 per annum.

Team-work and Discovery in Science

In his Perkin Medal Address, entitled "The Metallurgy of the Unusual", delivered before the American Section of the Society of Chemical Industry in New York on January 10, Dr. W. S. Kroll took issue with those who claim that the days of 'sealing wax–baling wire' science are over. The fight of the individual against the collectivity in which he lives is as old as humanity and it will never cease to exist. While Dr. Kroll granted that the team could not be avoided in development work, he challenged its justification in research. He questioned whether

leadership can be created in such a system: when teams are put to work to make important discoveries or inventions, they either fail dismally or are far too costly. He maintained that many laboratories in the United States are over-fond of gadgets and complicated equipment which often take more time to repair than to use. These instruments remove the investigator from his experiment; automatic research tools can thus be a great handicap to invention and progress. We have to offer the recalcitrant lone-wolf research worker some asylum since he is now menaced with extinction. His help is indispensable in the early stages of any new development and he acts like a scout, prospecting new territory before it is exploited by the crowd. The inventor or scientist needs self-expression and the affirmation of his personality: to try to depersonalize him in a team is psychologically a great mistake. Very great discoveries, in Dr. Kroll's opinion, are still so close to the surface that they can be unearthed with little expense by nonconformists with an inquisitive mind, with knowledge, the urge to create and who are prepared to accept sacrifice as a way of life.

Acta Meteorologica Sinica

Three issues of the periodical *Acta Meteorologica Sinica* have been received from the Institute of Geophysics and Meteorology of the Academia Sinica, Peking. Each contains six or seven papers. The papers themselves are in Chinese but each has a summary in either English or Russian, with roughly equal numbers of summaries in each of these languages. In the issues received, all the papers are on dynamical and synoptic meteorology with the exception of one on hygrometry. Frequent references are made to recent European and North American meteorological literature. Typical titles are "A Test for 24 and 48 hr. Numerical Forecasting with a Quasi-geostrophic Two-parameter Model" and "Statistical Investigation on the Blocking Situations over Asia". It does not seem that numerical forecasting with electronic computers is yet under examination in China, but Fjørtoft's graphical method is in use. Study of the papers would be easier if titles in English or Russian were given to figures and tables and perhaps even isopleths might be labelled, and columns and rows headed in one or other of those languages. It would also be very helpful if personal names of authors could be given in Latin script as well as in the Cyrillic form.

Cleveland Museum of Natural History, Ohio

Under the title of "A Reason for Pride" (Cleveland, Ohio: Cleveland Museum of Natural History, 1957) an attractive booklet describes how the site of the well-known Cleveland Museum of Natural History is required for a development plan of the city and the progress that the Trustees have made with a new building. At the outset, mention is made of the great assets of this Museum, and a brief résumé is given of the chief collections assembled during the past thirty-seven years. The new site is in Wade Park and covers eleven acres. Building is already in progress, and when completed will include a Hall of Nature, a Gallery of Man, a Hall of Science, and a Planetarium. In addition, the grounds surrounding the Museum will be made into a Nature garden containing outdoor exhibits of flowers, shrubs and trees native to the Cleveland district. All exhibits, both inside and out, will be planned in sequence to cover systematically the subjects of Nature and science in all their phases.

Agricultural Research

"Funds for Research in Agricultural Experiment Stations, 1953–54" is No. 8 in the series "Reviews of Data on Research and Development" issued by the U.S. National Science Foundation. Expenditures for research by agricultural experiment stations in the United States increased tenfold from 7 million dollars in 1920 to more than 74 million in 1953–54; 17 million for basic research and 57 million for applied research. Research funds for these stations came, for the most part, from the State governments and supplemented the core of support provided by the Federal Government. The States accounted for 45 million dollars; the Federal Government for 13·5 million, and other sources, such as sales and royalties, for 16 million. The 53 stations, practically all administered by the land-grant colleges and universities, are the fountainhead of agricultural research in the United States. The largest amounts were devoted to animal production and field crops; the smallest, to genetics and farm forestry. Copies of the report can be obtained from the National Science Foundation, Washington 25, D.C.

Tetrahydrothiophen

Tetrahydrothiophen (called tetrahydrothiophene in the trade) is a colourless liquid with a fairly high boiling-point (above 120°) but low flashpoint (64° F.) which is now in production in England by Robinson Bros. Ltd., Ryders Green, West Bromwich. The substance has a strong odour of coal-gas and is used in odorizing colliery methane and natural gas (see *Nature*, **180**, 1444; 1957) and also re-formed petroleum gases before they are used in town gas supplies. These gases are otherwise practically odourless and in that condition would not betray their presence in case of leakage. The odorized gases, on the contrary, have the characteristic smell of ordinary coal-gas. Details are available from the manufacturers on request.

Shelter Belts and Microclimate

A line of work in the Forest Products Laboratory with a probable future for research is connected with shelter belts. In the past century, in the south of Scotland and the north of England, shelter belts were planted by landowners for the protection of stock and crops. In order to save land, they were usually much too narrow and often consisted of Norway spruce. When the trees had attained a certain height and weight in the crowns a winter gale would either blow them down or more usually make a hole at one end from which successive gales would sweep away the plantation. The Forestry Commission has recently published its Bulletin No. 29 on "Shelter Belts and Microclimate" (London and Edinburgh: H.M. Stationery Office, 1957), by Dr. J. M. Caborn, of the Department of Forestry, University of Edinburgh, to whom it gave a grant and assistance in carrying out the research work. The investigation included wind, temperature, atmospheric humidity, evaporation and transpiration, soil moisture, precipitation and snow distribution, the economic significance of the influences of shelter belts and general conclusions on shelter-belt types, lay-out and structure. Help was received from the Department of Meteorology,

Imperial College of Science and Technology, London, from the Danish Heath Society, from the Swiss Forest Research Institute, Zurich, from the Meteorological Office and from colleagues on the forestry staff at Edinburgh. The results, if put into force, should provide a different type of shelter belt in Britain both in density and quality of timber. The Bulletin should prove of use in Colonial countries where shelter belts on a larger scale are very much needed for the improvement of agricultural crops and stock.

Biochemistry and the International Union of Biological Sciences

A COMMITTEE of the Section of Biochemistry of the International Union of Biological Sciences has recently been formed. It is essentially a co-ordinating committee between the International Union of Biological Sciences and the International Union of Biochemistry. It is assumed that this committee will be specifically concerned with chemical biology within the framework of the Unions federated in the Council of Scientific Unions. An important function of the committee will be to make proposals for international symposia to both Unions. It is hoped that a full committee meeting will shortly be held, perhaps during the fourth International Congress of Biochemistry in Vienna in September 1958. The committee as at present constituted consists of M. Florkin (Liège, *president*), O. Lindberg (Stockholm), R. Brunel (Toulouse), F. Lynen (Munich), P. Boyer (Minneapolis) and T. W. Goodwin (Department of Biochemistry, University of Liverpool, *secretary*).

Conference on Salt Marshes

THE Marine Institute of the University of Georgia has organized a Conference on Salt Marshes, to be held at Sapelo Island during March 25–28, 1958. The Conference is being sponsored jointly by the National Science Foundation and the Marine Institute. It will be international in character. Its purpose is to bring together scientists who are working on, or interested in, salt marshes, for discussion of research on this particular environment. An invited group of about twenty-five people will participate in the Conference; invitations will be extended on request to a limited additional number of persons who wish to attend at their own expense. The Conference is under the direction of Dr. Alfred C. Redfield, of Woods Hole, Massachusetts. Further information can be obtained from Dr. Robert A. Ragotzkie, University of Georgia Marine Institute, Sapelo Island, Georgia.

Low-Temperature Physics Conferences

THE sixth international conference on low-temperature physics will be held in Leyden during June 23–28, 1958, in connexion with the fiftieth anniversary of the first liquefaction of helium by Kamerlingh Onnes. Further information can be obtained from Dr. J. van den Handel, Kamerlingh Onnes Laboratory, Leyden, The Netherlands. A conference of the First Commission of the International Institute of Refrigeration will be held in Delft during June 17–20, 1958. At this meeting technical aspects of low temperatures will be discussed as well as scientific subjects. The secretary of the Delft conference is Prof. B. S. Blaisse, Mijnbouwplein 11, Delft, The Netherlands.

Announcements

MR. R. F. HAYMAN, industrial gas officer of the Gas Council, has been appointed chairman of the Industrial Gas Development Committee of the Council in succession to Mr. W. H. Tarn, whose term of office as chairman of the Committee expired on December 31.

DR. H. O. J. COLLIER has been appointed director of pharmacological research at Parke, Davis and Co., Ltd., Hounslow, Middlesex, from February 1. For the past twelve years, Dr. Collier has been head of the pharmacology department at Allen and Hanburys, Ltd., Ware, Herts.

RECOMMENDATIONS for the Meldola Medal, which will be awarded to the chemist who, being a British subject and less than thirty years of age on December 31, 1957, shows the most promise, as indicated by his or her published chemical work; and for Beilby Memorial Awards, given to young British investigators in science to mark appreciation of records of distinguished work, should be made by February 28. Further information can be obtained from the Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

THE Society of Protozoologists is to publish "A Catalog of Laboratory Strains of Free-living and Parasitic Protozoa", with sources from which they may be obtained and directions for their maintenance. This will appear as an integral part of the February issue of the *Journal of Protozoology* (5, No. 1). Reprints, which will be sold at a nominal cost, can be ordered from Dr. D. M. Lilly, Society of Protozoologists, St. John's University, Department of Biology, Jamaica 32, New York.

May and Baker, Ltd., state that from time to time they still receive empty Winchester quart bottles containing small amounts of sodium wire. Although all bottles that have been used for ether are examined before washing, it is difficult to detect such small pieces of sodium. This practice has resulted in several incidents, potentially serious, in the bottle-washing plant. In the interests of safety, any residual sodium metal used to dry the ether should be carefully and completely decomposed with a low-boiling alcohol before return to the supplier. Drying in this way is not necessary with the very dry grade of ether now available when required.

THE tenth British Mathematical Colloquium will be held in Reading during March 26–28. Further information can be obtained from J. E. Reeve, Department of Mathematics, The University, Reading.

THE Anniversary Meeting of the Chemical Society will be held in Bristol during March 31–April 2. There will be symposia on "Developments in Aromatic Chemistry", "Applications of Electron and Nuclear Resonance in Chemistry" and "Recent Work on the Inorganic Chemistry of Sulphur". Further information can be obtained from the Secretary, The Chemical Society, Burlington House, London, W.1.

IN *Nature* of December 28, 1957, p. 1448, reference was made in the article entitled "Lubrication and Wear" to an international discussion on the subject twenty years ago under the chairmanship of "the late Dr. H. J. Gough". We are glad to learn that a mistake was made and that Dr. Gough is still alive.

A WAGES POLICY

THE most pressing problem in the British economy is the race between the growth of personal incomes and the rise in industrial output. It was fitting, therefore, that, during the annual conference of the Institute of Personnel Management which was held at Harrogate during October 4–6, the 800 members attending were invited by Sir Richard Snedden, director of the Shipping Federation and chairman of the Industrial Relations Standing Committee of the British Employers' Confederation, to consider the means of dealing with this apparently intractable problem. Sir Richard made it very clear that there was no universal prescription for good industrial relations. These depended upon individuals; they had to be established gradually, patiently and even laboriously. The first essential is that each side must be confident of the good faith and integrity of the other. The next is leadership, but it must be responsible leadership including courage on both sides to take the unpopular decisions that responsibility sometimes entailed. The best way to build up confidence and to create effective leadership was for employers' and employees' representatives to meet frequently, preferably to discuss less-controversial matters, rather than meeting only at long intervals over such questions as hours of work and wages. The third essential is to avoid bringing in third parties except as a very last resort.

The classic approach to wages is that each industry should give the best wages that it could afford in order to get the best labour. The determining factor in wages-levels is the ability to pay, but there is no simple universal formula linking wages to production. There are seven reasons which seemed to make the discovery of a uniform magical slide-rule rather improbable.

First, it would be necessary for the Trades Union Congress and the British Employers' Confederation to reach an agreement and to bind their members. The Trades Union Congress is a powerful body, but it has never claimed to supervise, much less regulate, the wage claims of its component parts. The British Employers' Confederation is in the same position.

Secondly, the measuring rod usually suggested is the general index of industrial production. That index is not and cannot be comprehensive, and, at the outside, covers only half the employed population.

Thirdly, there are inherent weaknesses in any index of production. The proportion of products which are capable of unambiguous measurement and comparison at different dates is relatively small.

Fourthly, even if one took not the general index, but the component indices for individual industries or groups, labour is not the only claimant—although a most important one—to a share in the benefits of increased production. The consumer has a claim for lower prices. Capital also has a claim.

Fifthly, the actual increase in production would inevitably vary from industry to industry, from firm to firm, from department to department and even with individuals. It would not be easy to convince those acquainted only with their own personal increased efforts to share the benefits with others.

Sixthly, in considering wages, what are called 'fringe' benefits must not be left out of account. Reduced hours, increased pensions, and increased holidays can be just as inflationary as a direct increase in wages. They may even be more inflationary because they are likely to be more permanent.

Lastly, a scarcity of anything leads to higher prices and even a 'black market'. Why should labour be any exception?

It is shortage of labour which makes employers yield increases of wages against their better judgment, and it might even be that shortage of labour sometimes compels some trades union leaders to put forward wage claims which they are not really convinced are in the best long-term interests of their own members.

The formidable difficulties are not all equally applicable to all industries. The course which Sir Richard thought must be pursued is first to create a climate of public opinion favourable to effective action to ensure that wage increases operate only where they are earned. The actual solution must be worked out by industries for themselves and to suit their individual circumstances.

The way in which wages policies in industry have developed was examined by Prof. D. T. Jack, of King's College, Newcastle on Tyne, chairman of the Courts of Inquiry into the engineering and shipbuilding disputes in 1957.

The traditional system of wage negotiation has some advantages. It provides a certain flexibility in the whole structure of wages. It has fostered a sense of responsibility on the part of the two negotiating parties in each trade and industry affected by this process.

There is, however, a frequently voiced demand for a strong type of unified, compactly designed or consciously planned wages policy to replace the traditional policy which has operated for so long. There are three main sources for this desire. The first is the recognition in many quarters that, in a period of inflation, the wage-price spiral is frustrating to all wage earners and most injurious to some.

The second is bound up with the effect of full, or, sometimes, over-full employment. Here we have a situation in which bargaining strength is heavily weighted on the side of the unions. Provided the monetary system is accommodating, it would be very surprising if wages were not pushed up by more than the overall increase in the productivity of labour, with the consequent increase in labour costs.

Then there are the economic planners, some of whom recognize that their calculations and guesses may be reduced to nothing if the wages section of the economy is allowed to follow its own course while the remainder of the economy is tied to a rigid plan.

If a unified wages policy is held to be desirable, the means of promoting it must be considered. Experience in other countries has not been encouraging. There have been experiments in the United States of America and certain countries of Western Europe which have not been strikingly successful in preventing inflationary tendencies. In Britain the trades unions have a strong dislike of any radical departure from the traditional sectional wage-bargaining pro-

cedure. Despite this, there has been some evidence in recent years that wage claims, apparently put forward independently, tend to conform to a certain pattern. Some years ago, nearly every wage claim was expressed in terms of an application for x shillings a week increase. The following year, nearly every wage claim was formulated in terms of an application for a percentage increase of y, and the following year it took a different form. The energy which might conceivably be devoted to the working out of a wages policy between, say, the Trades Union Congress and the British Employers Confederation, was concentrated on the type of suitable tactical procedures. In the old days, the usual practice was for wage claims to be presented, in the first instance at least, to the most prosperous industries. In recent years, there is some evidence that a rather different procedure has been followed. Wage claims have been presented, not to the most prosperous industries, but to other industries which, for some reason or other, are regarded as of public importance and which are either not profitable at all or barely profitable. Having succeeded there, the next step is to present a greater demand upon the prosperous industries with the simple argument that, if the non-prosperous industry can afford a wage increase of x shillings, then the more prosperous industries must obviously be able to afford x plus A shillings.

Some people believe that a wages policy could only be formulated by means of national negotiation at the very highest level. Representatives of the Trades Union Council would meet representatives of the British Employers' Confederation, and, between them, they would hammer out any wage increases for the following year. Such an experiment would meet with no success.

A wages policy cannot be considered in a vacuum, and must be related to the larger issues of economic, financial and monetary policy.

In the whole of the post-war period, successive Governments in Britain have failed to deal with those inflationary forces which lie within their own orbit of control; this complicates the question of what function any body charged with the formulation of a wages policy could usefully perform. Full employment with inflation requires the co-operation of the main economic groups within the community. How can that co-operation be most effectively secured?

Do the existing procedures for arbitration in Britain encourage inflationary tendencies? There would be considerable danger if any arbitrator were to obtrude into his decision his own personal judgment of the wider consequences of his award, if the wider consequences were not dealt with in evidence before him by people who were competent to present that evidence. If one or other of the parties appearing before an arbitrator were to present a statement on the wider issues for the economy as a whole, he would probably be told by the other party that it was a matter not within his competence.

The suggestion that arbitration should be made compulsory does not make for a more satisfactory solution. That being so, does the court of inquiry procedure provide a more elastic means of coping with the problem than the arbitration procedure? To some extent it does, because the terms of reference of most courts of inquiry enable these courts to inquire into the causes and circumstances of the dispute. There is the further point that the reports of courts of inquiry are generally reasoned statements and not merely decisions, as in the case of awards of arbitration.

On the other hand, reports of courts of inquiry do not provide a complete answer because their terms of reference again generally limit inquiries to the particular dispute which has arisen between the parties, and it is not usual for these courts to seek evidence on the wider issues which may be involved in a particular claim.

One of the main gaps in the present system of industrial relations in Britain is that, in the past, there has been no body which would speak with authority on the wider issues which are raised by major wage claims on the economy as a whole. Now, however, there is the Council on Prices, Productivity and Incomes. What good can such a body do? Parties to a dispute represent sectional interests, and their submissions are very properly dominated by those sectional interests. If we cannot go to the parties for enlightenment, where can we go? One cannot look to Government because of the persistent record of Government failure to deal with those inflationary forces which lie within the power of the Government to control. Governments which have failed in their responsibility are scarcely entitled to admonish or exhort the public, or sections of the public, for their apparent misdeeds. Moreover, a Government which intervenes in industrial disputes in a manner which is intended to influence a result could scarcely be said to be performing its traditional function of 'keeping the ring'. At the lower, administration-level, only two departments are concerned: the Treasury and the Ministry of Labour. Neither is quite fitted to perform the function which is now required. The Treasury is too far removed from the world of industrial relations and too academic in its approach to command the attention of the public or the interested parties by its bulletins or by its announcements. The Ministry of Labour probably has its ear too close to the ground and is too preoccupied with individual disputes to go far beyond its appropriate brief.

Those concerned with the conjoint problem of inflation and full employment must be prepared to do some fresh thinking about the traditional arrangements for dealing with wages generally. Up to the present, the record is mainly one of failure. Governments have failed, and the two sides of industry have equally failed, to show any imaginative approach to the issues which have now become real.

The attitude of the trades unionist to scientific development and human relations in industry was put by Lewis Wright, general secretary of the Amalgamated Weavers' Association and chairman of the Trades Union Congress Scientific Advisory Committee (see *Nature*, **180**, 1013; 1957). No trades union, said Mr. Wright, opposes the development of automation, but none will approve the development of the machine at the expense of human dignity. The trades unionist wishes to see the machine exploited and not the worker; the latter should receive some of the benefits accruing from the exploitation of the machine.

Besides the plenary sessions, a series of sectional meetings was held to consider the role of the shop steward in industry, industrial conciliation and arbitration, education for management, job analysis for managers and other staff, and ergonomics and industrial management. Reports of all these meetings have been published in the *Journal of the Institute of Personnel Management* (**34**, No. 342; Dec. 1957).

T. H. HAWKINS

THE HOME UNIVERSITIES CONFERENCE

THERE can be no doubt that the Home Universities Conference, held in mid-December each year, is achieving increasing importance. The topics chosen for discussion are always live, as the fact that the Conference is sponsored by the Committee of Vice-Chancellors and Principals should guarantee. In addition to four or so delegates from each university, there are always representative guests present—members of the University Grants Committee, of the Ministry of Education, headmasters and headmistresses of schools and distinguished visitors from Britain and abroad.

Last December, the first subject for discussion was "The Place of Residence in the University To-day"—chosen because of the recent publication of the report of the sub-committee of the University Grants Committee on halls of residence. The Conference was clearly a strong believer in the educational value of halls of residence, but doubted whether they are being provided quickly enough. "Every new generation is a new invasion of savages", and if it behoves universities to play their part in civilizing their students, halls of residence are demonstrably among the most efficient means for doing this. As Prof. W. R. Niblett said, they should not be merely fringe enterprises in a university: they are closely related to its very *raison d'être*. But though professors may almost all be converts to the cause of halls of residence, they are sometimes apt to regress rapidly when asked to make a contribution at a financial cost to the development of their own departments. Prof. Seaborne Davies penetratingly remarked that it is chiefly upon the support of the disinterested that halls of residence have to rely.

During the Conference someone might have pointed out that halls of residence are among the best assets to a modern university in capturing good students for any department. It is not in the quality of their research or their teaching that modern universities are most open to criticism. These often, indeed, are first-rate. But too many students who might in favourable circumstances have emerged as leaders, with a wide interest in life and able to make human contacts with ease, remain over-specialized and insufficiently awakened; and with increasing numbers of 'first generation' students in our universities this is increasingly true. Industry to-day realizes more and more that a period in a good hall of residence is an immense asset to a student, and especially perhaps to a scientist. For many scientists in their maturity are not going to be primarily scientists but managers—and therefore makers—of men.

The introductory speeches, and also the contributions to the discussion on halls of residence, acute though some of them were, scarcely brought out sufficiently fully the differences between the older and newer universities in the living conditions they provide. It was suggested, for example, that really large halls in modern universities might still have something of the same civilizing effect on their inhabitants as Trinity College, Cambridge—for few declared that to be too large. In actual fact, many do, of course, regard Trinity College as far too big; but it is at least doubtful whether a hall of residence in a modern university will be so potent in its influence unless size is limited to a reasonable number of students under each warden (possibly not more than one hundred), each student having a private room of his own in which to work and live a private life. Of course, this is not to deny for a moment, any more than the Niblett Report does, that groups of halls of residence on one site have many possibilities.

At the second session of the Conference, on "Procedure for the Selection of Undergraduate Students", the different points of view on this subject of people from universities and schools showed up sharply. Sir James Mountford, commenting on the report published a few months ago under the auspices of the Committee of Vice-Chancellors on "Applications for Admission to Universities", emphasized that the basic problem was the number of applications compared with the number of vacancies. In his view, there was deplorable chaos in the procedure for the selection of students. He did not believe that a clearing-house system was a practicable solution to the problem, though universities might well be less secretive about the number of vacancies they had. It seemed to him, however, that the chief remedies must be supplied by the schools themselves. They should refuse to let their weak candidates apply for university entrance at all. They should support a movement for transferring the parts of the examination for the General Certificate of Education on which selection is based, from July to some time in the spring term.

As representatives of the schools hinted, these proposals really left the universities with very little of the burden of the problem: it was evidently the schools, not the universities, who were required to make the difficult adaptations. It is not easy to refuse candidates a chance of getting into a university if parents and boys themselves are keen on such a chance being allowed. As for change of date for the General Certificate (Advanced Level) examinations: it must be remembered that sickness in schools is at its maximum in the spring term, and that the effect of such a change might be to cut to five terms the total sixth-form course of a number of boys and girls—both those hoping for a university career and those with no such intention—who needed at least six if they are to be given an adequate sixth-form training. In a sincere and practical address, Miss M. J. Bishop, herself a very experienced headmistress, protested against the continuing onerous weight of faculty requirements. These were a threat to all unexamined sixth-form work. The rampant individualism of universities was the despair of the schools.

Dr. C. L. Pratt, of Christ's College, Cambridge, supported the idea that a vigorous pruning of faculty requirements should be made. The Imperial Chemical Industries' bursary scheme suggested that some schoolboys at least can be orientated, after they have entered a university, to a scheme of specialized study—for example, in science—when their sixth-form course had been almost entirely concentrated on the arts. He emphasized that what matters most

in choosing candidates rightly for university entry is the shape of the curve of the candidates' progress up to the time of selection: Was a particular boy or girl likely to develop a great deal, or was he already near his peak? He suggested that the selector must not be professionally and whole-time on the job: he should be made to live with the people he chooses. Selectors should suffer the consequences of their own decisions.

In the discussions on this key subject of selection for university entrance, it is to be noted that the headmistresses were able to speak knowledgeably of the problems of entry to both older and newer universities. No headmaster from a grammar school made a contribution, and the heads of public schools who spoke could only speak about selection for Oxford and Cambridge. One fancies that within the next few years, with the intense pressure on university entry and little chance of any significant increase in the number of students taken at Oxford and Cambridge, the public schools will have to make themselves much more aware of conditions at modern universities. Incidentally, it was pointed out that in Scotland the examinations which determine entrance qualifications to universities start in mid-March each year. But England rarely learns from Scotland in such matters.

The final session of the Conference tackled the problem of academic mobility. The investigation undertaken by the Association of University Teachers in 1956 suggested that too many members of university staffs stayed too long in one place. 22 per cent even of professors have never taught in a university other than that in which they hold their chair. Prof. A. G. N. Flew, of the University College of North Staffordshire, pointed out that a period of university teaching overseas could be of immense value in broadening the mind—in indicating, for example, that the English division of the curriculum into arts and sciences was not part of an inevitable ordering of things. Dr. R. S. Aitken, vice-chancellor of the University of Birmingham, considered that mobility among science staff was about right but that among arts staff it was insufficient.

Discussion in the Conference indicated that there was a widespread feeling that at present there was too great a degree of academic immobility. In particular, it was held that universities ought to advertize senior lectureships wherever possible, whereas the almost universal present practice is to promote from within the institution. Strong pleas were entered for further exchanges within the Commonwealth: a number of Commonwealth countries are at a critical stage in their university development, and it would be of the greatest value to them that some of the best people should have a period of university service in them. But pleas were also entered for exchanges within the United Kingdom itself: even one term of teaching in a different university might be a great stimulus.

With the rapid increase in numbers of university staff during the past few years, there is to-day an altogether disproportionate number of university lecturers in the 30–40 age group. Some speakers saw a good deal of discontent ahead when many of these people were still lecturers and yet in the 50–60 age group. They suggested that this was an argument for providing more senior posts—more new universities even—for then there would be more chairs for which to compete.

There appear to be great differences between university departments of applied science in the closeness of their contacts with industry. In some, it is standard practice for lecturers in, say, engineering to be taken from industry and to return to industry after a period of teaching and research. In other universities this is rare. But the Conference did not clearly show what its mind was in this matter.

In fact, the Home Universities Conference is much better as an assembly to which thoughtful and challenging contributions can be made either from platform or floor than as a place in which there is a keen to-and-fro discussion. Perhaps this is inevitable when there is a large and representative collection of university dons assembled with their vice-chancellors in the comfortable and dignified—if apparently underground—William Beveridge Hall of the University of London. Be that as it may, British universities in general are in great debt to the University of London for its kindly and hospitable welcome to a Conference which is bringing together, as no other conference does, people from the staffs of all British universities at a time of year when they are prepared to be thoughtful in a creative way.

AUTOMATIC MEASUREMENT OF QUALITY IN PROCESS PLANTS

AUTOMATIC control has been utilized by the process industries for many years; indeed, many commercial processes in use to-day could not function efficiently without its aid. Over the past decade, however, the basic philosophy of automatic control has undergone a marked change as a consequence of the introduction of powerful new instrumental techniques. The function of automatic controllers has hitherto been that of regulating certain basic parameters of a process, in the hope that adherence to fixed values of such parameters—temperature, flow or pressure—would result in an end-product of unvarying quality. The analysis of the end-product has, of necessity, been carried out in laboratories remote from the plant, with the consequent introduction of long delays between the detection of variations in the end-product quality and the initiation of the appropriate remedial action on the plant itself. The economic benefits which could be obtained by carrying out such analyses directly on the process stream have stimulated the development of a wide variety of instruments for the purpose, many of which have passed the experimental stage and are now accepted as sufficiently reliable for plant use.

The Society of Instrument Technology is to be congratulated on its choice of "The Automatic Measurement of Quality in Process Plant" as the subject of the 1957 Conference, which had as its aim the bringing

together of research workers, instrument engineers and other workers in this field to discuss these developments and their common problems.

Membership of the Conference, which was held at University College, Swansea, during September 23–26, was restricted in order to promote informal discussion; it is noteworthy that a number of the Conference members were drawn from the United States, Germany, Holland, Norway and the U.S.S.R., so that the open discussions provided an international forum for the exchange of ideas.

The seven formal sessions of the Conference fell into two complementary groups; a number of papers were devoted to a review of the experience which has been gained with established instruments, while the second group explored the possible plant application of analytical techniques at present utilized only in the laboratory. In addition to the formal technical papers—which will be published with their associated discussions by Butterworths Scientific Press—the Conference heard two informal talks which related its main topic to fundamental issues. Prof. D. P. Eckman considered the basic problem of the optimization of control by on-line computation, while another guest speaker, Dr. W. P. Colquhoun, drew an illuminating comparison between the human senses and automatic instrumentation.

The opening session of the Conference was concerned with the adaptation of laboratory techniques to plant measurement. Laboratory analytical techniques are, for the most part, well established and well understood; it is natural to suppose that an automatic analysis can be carried through by the mechanization of the laboratory method, although such methods are often based on a sequence of discrete measurements and so are not readily adaptable to truly continuous operation. This point was stressed in E. Hodgson's paper, which described an instrument for the determination of the crystallizing point of batch samples. It is clearly advantageous to know the composition of a plant stream throughout the course of a reaction, rather than to know its composition at intervals, and it is therefore an obvious, if difficult, step to make the analysis continuous.

Three papers, which were presented in the following session, described the manner in which this further step had been accomplished for calorimetric measurements on town's gas—a measurement of considerable importance to the gas industry, which is bound by law to maintain certain standards of calorific value and purity in the gas supplied to consumers.

Considerable discussion was aroused by another of the papers presented in this session, in which the authors underlined the difficulty of securing representative samples of gaseous streams—a problem which, it is often said, is more difficult than the analysis itself. It is significant that this theme recurred frequently in papers devoted to a wide range of analytical techniques.

The need for continuous control has resulted in the extensive use of physical methods of analysis; this trend was reflected in the eleven papers, presented on the second day of the Conference, which reviewed the use of such diverse methods as mass spectrometry, vapour phase chromatography and refractometry.

Three of the papers were devoted to existing instruments working in the visible and infra-red region of the electromagnetic spectrum. Infra-red analysis is now well established as a process technique, in spite of the fact that it is often difficult to find completely characteristic absorptions, and considerable overlapping of the spectra is common. In practice, of course, such imperfections are overcome by corrective procedures, but it is clear that the fundamental power of the method would be greater if it were possible to obtain narrower absorptions and higher resolution. These features are characteristic of microwave spectra, which are also very sensitive to molecular structure. The potentialities of microwave spectroscopy in process control analysis were considered in a paper by Dr. J. Sheridan; a second paper, read by Dr. R. E. Richards, described yet another relatively new branch of chemical spectroscopy—nuclear magnetic resonance, which may well be applied to process stream analysis, although little published information is available on its industrial applications. To the plant engineer, perhaps, these techniques may appear to be too difficult and complex for eventual adaptation to plant use. He would, however, do well to ponder on the implications of the final paper of the day, read by Dr. E. T. Hall. Dr. Hall is well known to the archæological world for his work on the dating of antiquities by the analysis of their chemical composition. In the course of his research (which has included, among other achievements, the detection of the Piltdown skull forgery) Dr. Hall developed an X-ray fluorescent analysis instrument, which is to be manufactured commercially for process use.

The last session of the Conference was devoted to a review of the uses of radioactive isotopes in quality measurement and a stimulating paper by Prof. W. Fishwick, which provoked considerable discussion, on the possibilities of analysis by physical measurements of an out-of-the-ordinary character. The session ended with an open discussion on the engineering design of instrumentation.

The catholic nature of the papers given at this Conference was in itself an indication of the rapidity with which technologists adapt to their own problems the tools provided for them by research workers in other fields; it is obvious, nevertheless, that the transition from research tool to plant instrument is difficult and expensive. It is essential that an instrument for plant use should function reliably for long periods without attention, and that maintenance should be reduced as far as possible to standard procedures, so that it may be carried out by relatively unskilled personnel.

The development of such instruments must at the same time be accompanied by the development of the associated sampling systems, since both are essential to the successful operation of the analyser on the plant. It is evident that a great deal of effort is at present expended on the design of sampling systems to meet the needs of various sectors of the process industries, each of which must therefore devote in isolation technical man-power to problems which must, in many cases, share many points of similarity. The consequent inefficient use of skilled technologists might well be remedied by the adoption of some coherent plan of attack which would co-ordinate the efforts of both users and manufacturers, both of whom were represented at the Conference; it is to be hoped that the Society of Instrument Technology will act on the suggestion, so well received by the Conference, that the time is ripe for it to establish a working team to codify existing knowledge on sampling techniques and to correlate development work in this field.

SCIENCE IN UNITED STATES UNIVERSITIES

A SURVEY of scientific research activities at colleges and universities in the United States, published by the National Science Foundation as No. 6 of "The Reviews of Data on Research and Development", gives the number of scientists and engineers employed in the natural and social sciences during the academic year 1953–54 as 70,000.

Detailed information was obtained from 180 out of 190 institutions constituting almost all the schools granting advanced degrees in science, and more limited information was obtained from 807 out of the remaining 930 schools. The returns covered 62,251 or 90 per cent of the total, and of these 31,435 were engaged in research, 8,262 being full-time, the total full-time equivalent being estimated as 16,534. Of these latter, 5,481 were engaged in research (2,281 in engineering sciences, 1,077 in chemistry, 837 in physics), 3,508 in biological sciences, 2,171 in chemical sciences, 3,658 in agricultural sciences, 389 in psychology, and 1,327 in social sciences.

The 180 larger institutions reported 24,000 supporting personnel, corresponding to a full-time equivalent of 15,060, giving a ratio of approximately 1 : 1. Of the 46,500 faculty members in the natural and social sciences at the 180 larger institutions, about 37,500 were employed full-time, and two-thirds of all the faculties spent some time on research, representing two-fifths of the total faculty-time, whereas in 807 small institutions less than 2 per cent of faculty-time was devoted to research, less than 10 per cent, or 16,000, employed being engaged in research.

Nearly 1,500 professional schools were reported by the 987 institutions, of which 764 were in arts and sciences, 131 engineering, 106 health, 71 agriculture, 217 research organizations (mainly responsible for a particular field of research) and 263 other professional schools. Two-thirds of the institutions were private and the remaining public-controlled institutions employed 56 per cent of the total engaged in the natural and social sciences, 61 per cent of which were engaged in research.

STARLING ROOSTS

A FASCINATING account of the way in which starlings roost and the sites they choose has been given by H. A. S. Key in the *Bedfordshire Naturalist* (11 ; 1957). Starlings are abundant in Bedfordshire, and the many resident birds are considerably augmented during the winter months by many thousands of others which arrive chiefly from Scandinavia. At night the birds congregate in communal roosts which are usually sited in thorny copses and spinneys. In general, once a roost has reached an optimum condition of growth and non-disturbance, it is used for many seasons. At each roost the pattern of assembly is much the same. The birds fly at first in leisurely stages towards the roost, but as the daylight fades and they get nearer to the point of assembly, their flights are more direct and flocks tend to converge and amalgamate.

The point of assembly is close to the roosts and often on the ground, where the birds form a dark carpet and the noise of their whistling and chattering is considerable. Then, suddenly, they get up, often indulging in some preliminary aerobatics, first in extended and then in close formation, before the entire party moves in a steady stream into the roost proper. Here with a great deal of commotion they wheel around and settle on the trees. For a short period there may be changes of perching areas within the roosting wood, but finally, when it is almost dark, the whole mass of birds is assembled in the regularly used part and then as each stem becomes packed with the jostling mass the din reaches its crescendo. From this tight grouping they are then not easily disturbed and sharp noises such as hand-clapping usually only suffice to cause the nearest group to move a few yards away.

In north Bedfordshire it would appear that the majority of the birds frequent one or other of two very large roosts, the populations of which would be hard to determine. These are Horn Wood, near Bozeat, Northants, just outside the west boundary of the county, and another site near Everton in the east. There was some years ago a smaller roost in Keysoe Park Wood, but this seems to have been abandoned.

THE NATIONAL TRUST

ANNUAL REPORT, 1956–57

THE sixty-second annual report of the National Trust, for 1956–57, makes slight reference to the threats offered to its primary duty of ensuring the safety of fine open country or fine buildings which arise from Government departments or other public authorities. Some evidence is recorded of increasing public appreciation : in 1956 nearly 900,000 visitors paid for admission to those properties where an entrance fee is charged, an increase of more than 200,000 on 1955, and membership increased by more than 5,500 to 61,713, with a further increase of 3,740 during the first seven months of 1957.

Nevertheless, the Council's hope that the 100,000-mark will be reached in 1959 seems modest indeed and far too low, either to relieve the Council of continuing financial anxiety (in spite of a small surplus in 1956, when membership income increased by £17,000) or to ensure the widespread public

understanding and support necessary to avert the increasing destruction and vulgarization of the countryside, country towns and villages. While the position of the country house to-day seems slightly less gloomy and in archaeology a considerable sum has been spent in the past eighteen months on the preservation of the Cerne Giant in Dorset, repairs have been commenced to the Roman ruins at Ribchester, and satisfactory progress is reported in repairs to the Roman wall at Hotbanks, the report expresses the opinion that the face of England is rapidly changing for the worse.

Cafés, petrol stations, advertisements, neon lights, concrete lamp-standards, ill-sited and ill-designed, are everywhere, and persistent irresponsibility is shown in siting high-power cables, nuclear power stations and radar installations. The Trust has protested more than once during the past year against such ill-considered siting, but although this desecration is viewed with anxiety and regret the Council believes that a change of faith in official quarters and the establishment of a new canon of taste could, even now, save the situation and repair much damage already done. The Council appeals to members for active support in its practical proposals for dealing with the development of the English landscape, and in particular the report urges the importance of reducing signposts to the essential minimum and for far more thought in their design and siting.

GROWTH AND REPRODUCTION IN WORM-FREE SHEEP AT PASTURE

By Dr. C. R. W. SPEDDING, T. H. BROWN and I. A. N. WILSON
Grassland Research Institute, Hurley, Berkshire

NEMATODES parasitic in the alimentary tract have been shown to cause a depression of the growth-rate of lambs maintained indoors[1,2] even when the level of infestation has been sub-clinical. This has been confirmed for lambs at pasture[3], and it has been found possible to raise lambs free from stomach and intestinal worms (with the exception of *Strongyloides papillosus*) by rapid folding over clean pasture[4].

Thirteen Suffolk × half-bred ewe lambs reared with their infected ewes in this way in the spring of 1956 were weaned on to 6 acres of worm-free pasture (that is, one not grazed by ruminants for at least two years) in June of that year. They remained on this area, for the most part set-stocked, until April 1957, with the exception of three weeks (Oct. 29–Nov. 23, 1956) when they were brought indoors to be tupped. This procedure was necessitated by the absence of a worm-free ram. At the same time, 15 of the best remaining ewe lambs from the farm flock were selected for comparison. The previous live-weight history of these two groups is shown in Fig. 1. The decline in live-weight gain of the infected ewe lambs (Group *I*) during the autumn was characteristic of sheep of that age on the farm and occurred in spite of grazing a better pasture than that available to the worm-free lambs (Group *F*). Thus, at tupping time, Group *F* lambs were, on average, 17 lb. per head heavier than those in Group *I*. The latter were maintained throughout the tupping period on a nearby field, and the same ram was employed for both groups, spending the day in the field and being brought in to Group *F* at night.

On November 23 Group *F* was returned to its field, and Group *I* was grazed on a comparable, and at no time inferior, sward. Fig. 1 shows the subsequent mean live-weight changes for both groups of sheep. From January 16, 1957, concentrates (80 per cent cereal, 15 per cent dried lucerne meal, 5 per cent linseed cake) were fed to both groups at the rate of ¼ lb./head/day, rising gradually to 1 lb./head/day on February 25 and continuing at that rate until April 24. A mineral mixture rich in magnesium was included to prevent hypomagnesæmia.

The egg counts for each group are shown in Fig. 2. The egg-count curve for Group *I* was typical of sheep of that age at that time, but rather low. Group *F* fæces were negative for parasite eggs until the sheep were brought inside for tupping, when a mean count of 2 eggs per gm. was recorded. This declined to

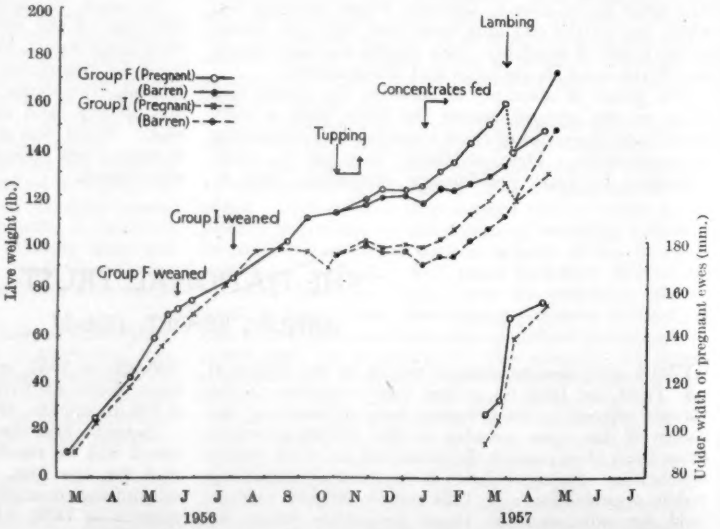


Fig. 1. Mean live weights and udder measurements of Groups *I* and *F*

Table 1. Data for Ewes and Lambs as Means for each Group

Group	Live-wt. gain of ewes (lb.)		Udder width of ewes at lambing (mm.)	No. of barren ewes	No. of lambs born dead or died within 12 hr. of birth	Length of gestation period (days)	Birth-wt. of lambs (lb.)		Live-wt. gain from birth to 28 days Singles (lb.)
	Barren. 29.10.56–26.3.57	Pregnant*. Tupping to post-lambing					Singles	Twins	
F	20·9 (4)†	25·9 (6)	148 (9)	4	0	143	11·3 (7)	7·2 (4)	25·5 (6)
I	15·9 (6)	25·8 (6)	139 (8)	6	2	143	8·4 (7)	6·7 (2)	23·9 (6)
Difference	5·0	0·1	9	—	—	0	2·9	0·5	1·6
Per cent difference	31·4	—	6·5	—	—	0	34·5	7·5	6·8

* Based on weight gains of ewes with single lambs only.
† Numbers of animals are given in brackets.

zero and remained so until lambing time, when eggs again occurred. This shows that Group *F* carried a few worms which, at times of stress leading to a temporary lowering of resistance, produced measurable numbers of eggs. The parasitological consequences of this to ewes and lambs will be dealt with elsewhere.

Since it is not possible to prove that any group of living sheep has no worms at all, it has been suggested[5] that a 'worm-free' sheep be defined as one that normally shows no evidence of infestation even when set-stocked on pasture with every opportunity for re-infection. In this sense Group *F* were worm-free over the year considered here. The live-weight gain of the ewes from tupping to lambing included any differential growth of fœtus and maternal tissue: the mean difference in live-weight just before lambing on March 26, 1957, was 32 lb./head in favour of Group *F*. The ewes were weighed within 24 hr. of lambing, however, and the gain in body-weight has been calculated for the period from tupping to this post-lambing weight (Table 1). At intervals during late pregnancy and lactation, udder-widths were measured on all the ewes, the width being the distance across the teats measured externally at the base of the teat. Group *F* udder-widths exceeded those of Group *I* by 6·5 per cent at lambing time (Fig. 1).

The birth data for the lambs produced by both groups are given in Table 1. Group *F* produced significantly heavier single lambs ($P < 0.01$) than Group *I*; there were fewer barren ewes and lower mortality. Two lambs in Group *F* suffered from mis-mothering and had to be removed; one of them died later. There was no difference in the length of the gestation periods. There were too few twins to make a meaningful comparison of their weights or growth.

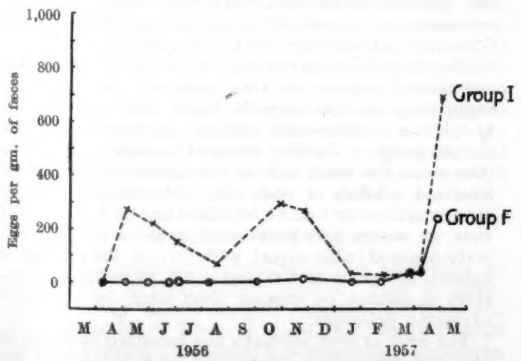


Fig. 2. Mean egg-counts of Groups *I* and *F*

The arrangements for tupping were of necessity restrictive and preclude a valid comparison of lambing percentages. The differences observed in the birth-weights of the lambs may be attributed either to the presence and absence of worms over the whole life of the ewe or merely during pregnancy. Worm-infestation before pregnancy resulted in a mean difference of 17 lb. per head in November. There was, however, no correlation between the weights of the ewes at tupping time and the birth-weight of their lambs in either Group *I* (with a range of 17 lb. in ewe weights) or Group *F* (with a range of 30 lb.). Moreover, infected ewes produced considerably lighter lambs than worm-free ewes of comparable weight at tupping time. Thus it seems unlikely that the lower lamb weights can be attributed to the fact that the infected ewes were lighter when mated. The number of twins was small, but the ewes that bore twins were among the heaviest in each group.

The infection carried by Group *I* ewes during pregnancy, although light in terms of fæcal egg counts, was clearly the major factor. The non-pregnant ewes of Group *F* gained 31·4 per cent more weight during the winter period (October 29, 1956–March 26, 1957) than those of Group *I*; numbers were small, however, and this difference was not statistically significant. The growth of the in-lamb ewes of each group from tupping to lambing (based on immediate post-lambing weights) was the same. The effect of worm-infestation was therefore just over 30 per cent in both non-pregnant and pregnant ewes but in the latter it affected only the fœtus and the associated maternal tissues. In Group *F* the pregnant ewes carrying singles gained slightly more body-weight than the non-pregnant animals; in Group *I* the difference was much greater, though not statistically significant. Thus the effect of worm-infestation appeared to be greater on barren than on in-lamb ewes and did not affect the growth of the latter, except in a reproductive sense. The growth of the pregnant ewes of Group *I*, in fact, was equal to that of Group *F* and appears to have taken complete priority over the growth of the fœtus.

The udder-width measurements differed by 6·5 per cent, which might indicate a lower capacity to produce milk. This suggestion was supported by the growth of lambs from birth to 28 days old: single lambs in Group *F* gained 6·8 per cent more weight during this period. These differences were not statistically significant; but it should be noted that the majority of Group *F* single lambs were female (6 out of 7) while the majority of Group *I* lambs were male (5 out of 7). There was no correlation of birth-weight with growth to 28 days in either group.

Twenty-eight days after the birth of the lambs, therefore, Group *F* single lambs were 11·3 per cent heavier than those of Group *I*; the barren ewes were 16 per cent heavier and the ewes suckling single lambs were 13·8 per cent heavier in Group *F*.

This suggests that the effect of a moderate degree of worm infestation on the growth of ewes is similar to that found for other sheep[3] but that in pregnant ewe lambs the effect may be suffered entirely by the developing fœtus and the associated maternal tissues.

We wish to thank Dr. William Davies for facilities granted, Mr. C. D. Kemp for the statistical treatment of the results, and Mr. J. E. Betts for technical assistance.

[1] Spedding, C. R. W., *Emp. J. Exp. Agric.*, **21** (84), 255 (1953).
[2] Gibson, T. E., *J. Comp. Path.*, **64**, 360 (1954).
[3] Spedding, C. R. W., *J. Brit. Grassl. Soc.*, **10** (1), 35 (1955).
[4] Spedding, C. R. W., *Nature*, **174**, 611 (1954).
[5] Spedding, C. R. W., *Outlook on Agric.*, **1** (3), 101 (1956).

LOCALIZED ELECTRONS IN BODY-CENTRED CUBIC METALS

By J. S. GRIFFITH and L. E. ORGEL
Department of Theoretical Chemistry, Cambridge

IN this article we gather together experimental evidence supporting a recent idea about the electronic structure of body-centred cubic transition metals proposed by one of us[1] and developed by the other[2]. A closely related theory has been given independently by Stevens[3]. We suggest, essentially, that the valence orbitals on a given metal atom can be divided into two classes, the orbitals of one of which bond strongly with the rest of the lattice, and those of the other only weakly.

In a body-centred cubic metal each atom is surrounded by eight others at the corners of a cube, so that the site symmetry is cubic. We discuss at first the metals of the first transition series as most of the experimental data refer to them, although a qualitatively similar discussion would apply to the other two series. The 3*d*-, 4*s*- and 4*p*-orbitals are then the important valence orbitals, the 4*f*- and other orbitals probably making only a minor contribution to the cohesive energy. Under the cubic group these orbitals form bases for representations the irreducible components of which are shown in Table 1 (in the usual notation, see ref. 4). The main bonding interaction is presumably the σ-interaction between nearest neighbours. Table 1 shows that the *s*-, *p*- and $d(t_{2g})$-orbitals can take part in this, but that the $d(e_g)$-orbital cannot. (The $f(a_{2u})$ and $f(t_{1u})$ but not the $f(t_{2u})$-orbitals can also take part in σ-bonding but we shall not consider *f*-orbitals here.)

If we take rectangular Cartesian axes centred at a site and parallel to the cube edges, then the nearest neighbour nuclei lie along the directions of the eight vectors $(\pm 1, \pm 1, \pm 1)$. The two *d*-orbitals of the e_g representation are then d_{z^2} and $d_{x^2-y^2}$ and each has zero amplitude along all the nearest-neighbour directions. This shows in a more immediate way that they cannot σ-bond along any of them. A consideration of the angular variation of *s*, *p* and the three t_{2g}-orbitals (d_{xy}, d_{yz}, d_{zx}) shows readily that the σ-interaction allowed by group theory should really be large provided that the radial functions allow sufficient overlap. Hence, to the approximation of considering only σ-interaction with nearest neighbours, the seven valence orbitals $4s$, $4p_x$, $4p_y$, $4p_z$, $3d_{xy}$, $3d_{yz}$, $3d_{zx}$ bond and are able to hold the metal together, while the two orbitals d_{z^2} and $d_{x^2-y^2}$ are entirely non-bonding. We call the former class 'bonding orbitals' and the latter class 'localized orbitals'.

Table 1. Representations Spanned by Atomic Orbitals at a Site and Nearest Neighbour and Next-Nearest Neighbour σ- and π-Orbitals in a Body-Centred Cubic Lattice

Atom	Orbital	Representations
Site atom	*s*	a_{1g}
	p	t_{1u}
	d	$e_g + t_{2g}$
	f	$a_{2u} + t_{1u} + t_{2u}$
Nearest neighbour	σ	$a_{1g} + a_{2u} + t_{1u} + t_{2g}$
	π	$e_g + e_u + t_{1g} + t_{1u} + t_{2g} + t_{2u}$
Next-nearest neighbour	σ	$a_{1g} + e_g + t_{1u}$
	π	$t_{1g} + t_{1u} + t_{2g} + t_{2u}$

It may clarify matters to relate our treatment to those postulating hybrid σ-bonds directed towards the corners of a cube (that is, towards the nearest neighbours). Van Vleck[5] showed that it is possible to construct eight equivalent hybrids from $sp^3d^3f^1$. Here the *f*-orbital is f_{xyz} (or a_{2u}) and the remaining seven are our bonding orbitals. The two *d*-orbitals which cannot be used in these hybrids are our two localized *d*-orbitals. Thus in Pauling's resonating-bond model[6] for a body-centred cubic metal the resonating bonds are formed only from our bonding atomic orbitals and never from localized ones.

If we include π-bonding and next-nearest neighbour interaction in our theory the distinction between the two classes of atomic orbitals is no longer complete. The e_g-orbitals can π-bond with the nearest neighbours and σ-bond with the next-nearest neighbours (this latter circumstance is to be related to the possibility of constructing octahedral sp^3d^2 σ-hybrids). The other orbitals also have extra bonding possibilities, as one sees from Table 1 (in an earlier paper (ref. 1, Table 2) the nearest neighbour π-interaction of the $d(t_{2g})$ orbitals was incorrectly omitted). However, the general conclusion that the seven 'bonding' orbitals are relatively strongly bonding while the two 'localized' orbitals are only weakly so should still hold.

The discussion we have given so far suggests that one should regard the two localized orbitals in the same way as one regards inner shell orbitals, or 4*f*-orbitals in rare-earth metals. In other words one should assign a definite integral number of electrons (the same for each site in the metal) to the set of localized orbitals at each site. Denoting a bonding atomic orbital by *b* and a localized one by *l*, this means that we assign a definite configuration $b^m l^n$ to each body-centred cubic metal, with $(m+n)$ the number of valence electrons and *m* and *n* yet to be determined. Here *n* cannot be greater than four, by the Pauli exclusion principle.

For $b^m l^1$ or $b^m l^3$ we have the localized electrons at any site forming a component of a ^2E_g state; for $b^m l^2$ the pair of localized electrons could belong to

Table 2. CONFIGURATION ASSIGNMENTS FOR BODY-CENTRED CUBIC FIRST TRANSITION-SERIES METALS
Hypothetical body-centred cubic metals in brackets

Metal	K	(Ca)	(Sc)	Ti	V	Cr	Mn	Fe	(Co)
Configuration	b^1l^0	b^2l^0	b^3l^0	b^4l^0	b^5l^0	$b^{5-e}l^{1-e}$	b^6l^1	b^6l^2	$b^{8-f}l^{2-f}$

$^3A_{2g}$, $^1A_{1g}$ or ^1E_g states. Using Racah's notation[7], the $^3A_{2g}$ state lies lowest in energy, with the ^1E_g state lying $(8B+2C)$ above and the $^1A_{1g}$ state the same amount higher still. The symbol b^m refers to a situation which cannot be described in any simple fashion. If there are N metal atoms, the mN bonding electrons could, of course, be assigned to bands formed from bonding orbitals. This would, however, involve an approximation introduced only for ease of calculation, but which is not implicit in our model. Our assignment of the configuration symbol b^ml^n merely implies that in the metal mN electrons are in bonding atomic orbitals (we allow polar structures for b^m but not for the localized electrons) and that on each site n electrons are in localized atomic orbitals.

In principle, to describe a metal with two localized electrons one should take the best linear combinations of functions each of which is a product involving $^3A_{2g}$, $^1A_{1g}$ or ^1E_g states at each site. One could not then say that l^2 at a given site and for a given total electronic function is a definite one of the possible site states $^3A_{2g}$, $^1A_{1g}$ or ^1E_g. However, one would naturally expect the lowest eigenfunctions based on configurations b^ml^2 to correspond to states which are almost entirely $^3A_{2g}$ at each site, and this is an assumption of our theory.

The next problem is to decide what the individual values of m and n are. At the beginning of a period, one expects the electrons to go into the bonding orbitals. Thus body-centred cubic potassium would be b^1l^0. It would be difficult to decide from *a priori* considerations when the electrons start going into the l-orbitals. If one accepts our model, however, the experimental data for the first long period strongly suggest that the first six electrons go into b-orbitals and then the l-orbitals start filling up at least until two electrons are in them. The configurations we propose for body-centred cubic metals, then, are shown in Table 2.

In a more complete discussion we would consider interconfigurational interactions. To have a complete set of basic configurations we would include structures having different numbers of localized electrons on different sites. Our proposal is, however, that we may usually restrict attention to one of the special configurations b^ml^n without great inaccuracy. We shall find that the magnetic evidence may indicate a mixture of configurations for chromium, and then, of course, the majority of low-lying states will be linear combinations of functions corresponding neither to b^6l^0 nor to b^5l^1, but of functions corresponding to $n=0$ on some sites and $n=1$ on others.

We now pass on to show how the experimental data accord with our model and the above assumption about the individual values of m and n.

Magnetic Properties

Neutron diffraction experiments[8] on vanadium do not indicate any magnetic moment. This we interpret to mean that vanadium has the configuration b^5l^0. Chromium[8], however, appears to have a small moment per atom, although the experimental position is not quite clear. This perhaps justifies the symbol $b^{5-e}l^{1-e}$ in Table 2. We regard the low-lying states of chromium as being formed from structures with no localized electron on most sites and perhaps with one on others.

Body-centred cubic iron is ferromagnetic with a saturation magnetization of 2·22 μ_B per site. Neutron diffraction confirms this figure[8]. It has been interpreted by supposing there are two electrons with parallel spins on each atom which then align ferromagnetically by an indirect interaction through a conduction band[9]. This interpretation, according to our point of view[1], means that iron is predominantly b^6l^2. The two localized electrons on a given site have their spins parallel because the lowest state of l^2 is $^3A_{2g}$. The 'conduction band' is roughly equivalent to b^6 in our model.

In view of the analogy between our localized d-orbitals and inner-shell $4f$ rare-earth orbitals, this model of ferromagnetism in iron is precisely analogous to the model for ferromagnetic gadolinium with the configuration b^34f^7 in which the localized $4f$-electrons carry the magnetic moment.

Electron Distribution

The spatial distribution of electrons in transition metals has been studied by Weiss and co-workers[10] using X-ray methods. They find that for face-centred cubic nickel and copper the electron density corresponds to an inert gas core together with the anticipated number of d-electrons (ten in copper and about nine in nickel) each having a radial distribution similar to that given by Hartree–Fock calculations. However, in body-centred cubic chromium there is no evidence at all for d-electrons with a normal radial distribution, while for body-centred cubic iron the electron density corresponds to the core and just two normal d-electrons.

The absence of any density corresponding to d-orbitals in chromium is very puzzling. Presumably the radial functions for the electrons used in bonding are very different from those in the free atom and so escape detection by the X-ray method. However, the presence of just two radially localized electrons in iron is nicely consistent with the suggestion that there are two non-bonding electrons present in the e_g orbitals[1], since a non-bonding electron would be expected to have a radial distribution not too different from that in the free atom.

The low-temperature phases of both chromium and iron are body-centred cubic, but while there is a body-centred cubic form of manganese at high temperatures the low-temperature manganese structures are very complicated. It has been suggested[1] that this is because in the configuration b^6l^1 anticipated for body-centred cubic manganese the localized electron in the doubly degenerate e_g-orbital would lead to a Jahn–Teller distortion of the lattice. Considered alone, this evidence would, of course, be very indirect.

X-ray Spectra

Finally we discuss the soft X-ray spectra of body-centred metals. Our theory would lead us to anticipate that the allowed transitions from the $2p$- and

3*p*-orbitals to the 3*d*- and 4*s*-orbitals would show one remarkable feature, namely, the presence of relatively narrow bands corresponding to transitions to the $3d(e_g)$-orbitals[8]. Furthermore, in chromium, since the e_g-level is just about to fill up, we should expect the narrow band to lie at the absorption edge. In iron, on the other hand, two electrons are already in the e_g-orbitals so that a third would be forced to go in with antiparallel spin. It follows that the most stable empty orbitals are bonding orbitals, so that the narrow absorption band should be preceded by some absorption involving transitions to the conduction band. Both these anticipated features have been reported in the M_{II} and M_{III} spectra of chromium and iron[11], but no explanation of them has previously been given.

It is perhaps necessary to remark that the X-ray spectra give the relative positions of different unoccupied orbitals only in a qualitative sense. The excitation of an inner electron increases the effective charge on the nucleus and so perturbs the energy-level scheme of the metal. If different orbitals are perturbed to different extents, the relative positions of these orbitals may be modified. In particular, a localized orbital will be more affected than an orbital which is part of a broad band, so the stability of the e_g-orbital will be exaggerated somewhat in the X-ray spectrum. The difference between chromium and iron, however, is unambiguous.

Additional Data

There is not much to say about the later transition series. Neutron diffraction indicates no atomic magnetic moments for niobium, molybdenum or tungsten, suggesting the configurations b^5l^0, b^6l^0 and b^8l^0 respectively.

In the second and third series the last element to have the body-centred cubic structure is that in group VI[12]. In the first period, however, iron has both this structure and a close-packed structure[13]. Now body-centred cubic iron has a stabilization of about 9 kcal./mole due to the exchange energy between the two *l*-orbitals[1], there being no such exchange energy in close-packed iron. Since the two structures are almost equi-energetic[13] one must suppose that there is a compensating gain of bonding energy in the close-packed structure. Accepting this empirical balance, one then expects the body-centred cubic structure to be less stable relative to close-packed structures for ruthenium and osmium because one knows that the exchange integrals (from atomic spectral data) are smaller, and the overall cohesive energies (and hence presumably bonding energies in the limited sense) are larger. Although ruthenium and osmium are hexagonal close-packed, whereas iron is face-centred cubic, one may still suggest that the fact that only iron of the group VIII metals forms a body-centred cubic structure is due to the two reasons given.

In neither the hexagonal nor the cubic close-packed metal lattices is it possible to find any *s*-, *p*- or *d*-orbitals which do not interact in a σ-fashion with nearest neighbours. Hence our discussion does not apply directly to them. This means that the ferromagnetism of cobalt and nickel cannot be discussed in the same way as that of iron.

We are indebted to Prof. H. C. Longuet-Higgins and Prof. N. F. Mott for their interest in this work.

[1] Griffith, J. S., *J. Inorg. Nucl. Chem.*, **3**, 15 (1956).
[2] Orgel, L. E., *J. Phys. Chem.*, **3**, 50 (1957).
[3] Stevens, K. W. H. (private communication). See also Mott, N. F. and Stevens, K. W. H., *Phil. Mag.*, **2**, 1364 (1957).
[4] Eyring, H., Walter J., and Kimball, G. E., "Quantum Chemistry" (Wiley, 1948).
[5] Van Vleck, J. H., *J. Chem. Phys.*, **3**, 807 (1935).
[6] Pauling, L., *Phys. Rev.*, **54**, 899 (1938).
[7] Racah, G., *Phys. Rev.*, **62**, 452 (1942).
[8] Shull, C. G., and Wilkinson, M. K., *Rev. Mod. Phys.*, **25**, 100 (1953).
[9] Zener, C., *Phys. Rev.*, **81**, 440 (1951). Pauling, L., *Proc. U.S. Nat. Acad. Sci.*, **39**, 551 (1953).
[10] Weiss, R., paper presented at Crystal Physics Conference, Massachusetts Institute of Technology (1957).
[11] Agarwal, B. K., and Givens, M. P., *Phys. Rev.*, **107**, 62 (1957). Carter, D. E., and Givens, M. P., *ibid.*, **101**, 1469 (1956).
[12] Wells, A. F., "Structural Inorganic Chemistry" (Oxford University Press, 1950).
[13] "Selected Values of Chemical Thermodynamic Properties" (National Bureau of Standards, Circular No. 500, Washington, D.C., 1952).

ORIGIN OF TEKTITES

H. H. NININGER[1] has proposed that tektites be regarded as the ejecta from lunar craters produced by meteorite impact. He points to the work of L. J. Spencer[2,3] comparing the tektites with glassy matter from terrestrial meteorite craters. The wide distribution of tektites of a single type, such as australites, argues in favour of lunar rather than terrestrial craters.

This theory is especially attractive because there appears to be direct evidence that spherical glassy bodies have been ejected from some of the ray craters. The evidence is the fact that long bright streaks diverge from these craters; and that these streaks appear to return light in the direction from which it came in the manner of a beaded-glass screen[4]. (Prof. M. Minnaert has informed me verbally that experiments at Utrecht on various surfaces have shown that the dependence of brightness on phase angle observed for the bright rays cannot be duplicated by plausible sorts of surfaces; but can be duplicated by scattered glass beads.) Furthermore, in at least one case, namely, Tycho, the streaks extend almost half-way around the Moon, and hence correspond to velocities of the order of the velocity of escape from the Moon.

Nininger seeks to explain the distribution of tektite finds, chiefly within 40° of the equator, as a consequence of lunar origin, the tektites having followed, he believes, a direct line between the centres of the Moon and Earth, and arriving in the tropics because the Moon is overhead only in these latitudes. This explanation is not satisfactory, since it assumes implicitly that the orbital velocity of the Moon is perfectly cancelled by the explosion velocity. If the cancellation is imperfect, the orbital plane will be determined by the centre of the Earth and the resultant velocity vector, and will be oriented more or less at random.

This difficulty can be removed if we assume that the Earth possesses an outer atmosphere, extending 10 radii or more, and having a density of the order of 10^{-21} gm./cm.^{3}. (Dr. H.-K. Paetzold, of the Max-Planck-Institut, has verbally confirmed this order of magnitude of the density of the atmosphere at 10 Earth's radii.) In this case, many of the particles

thrown from the Moon could be expected to encounter the extended atmosphere near perigee. The effect of the atmosphere will be to diminish the eccentricity and semi-major axis of the orbit of the particle around the Earth[5].

After a period of 10^7 years or the like, the orbit would become very nearly circular, and would approach the surface of the Earth. Owing to the attraction of the equatorial bulge of the Earth, the orbit would be more sharply curved where it crosses the equator. The equations of motion have been integrated for a closed, almost circular orbit which is symmetrical about the Earth's axis. It is found that the radius vector, r, can be expressed approximately as a function of the latitude φ for a meridional orbit by the relation :

$$r = r_0\left(1 + \frac{\alpha}{12}\cos 2\varphi\right)$$

where α represents the flattening of the Earth. On the other hand, the sea-level surface of the Earth can be described by the corresponding relation

$$r = r_0\left(1 + \frac{\alpha}{2}\cos 2\varphi\right)$$

It is seen that the orbital perturbations cancel only one-sixth of the effect of the Earth's ellipticity. It follows that such a satellite will be about 11 miles nearer the surface of the Earth at the equator than at the poles, and will be subjected to about fifteen times as much air resistance. It will thus nearly always come to Earth in latitudes near the equator, in accordance with the distribution found for tektites.

An example of a body describing such an orbit is provided by the meteor procession of February 9, 1913, described by C. A. Chant[6] and computed by the Rev. M. A. Davidson[7]. This group of bodies described a path 5,700 miles long from Saskatchewan to the South Atlantic at heights of the order of 40 miles. The orbit was clearly a nearly circular one about the centre of the Earth. W. J. Fisher[8] suggested that the bodies were intercepted by the equatorial bulge of the Earth.

It thus appears plausible that in the tektites we have portions of the lunar surface.

The kind assistance and advice of Mr. E. P. Henderson, of the U.S. National Museum, is gratefully acknowledged.

JOHN A. O'KEEFE

3712 Thornapple Street,
Chevy Chase 15, Maryland.

[1] "Out of the Sky", 302 (University of Denver Press, Denver, 1952).
[2] *Nature*, **139**, 655 (1937).
[3] *Mineralogical Mag.*, **24**, 503 (1937).
[4] O'Keefe, *Astrophys. J.* (in the press).
[5] Moulton, F. R., "An Introduction to Celestial Mechanics", 333 (Macmillan, New York, 1914).
[6] *J. Roy. Astro. Soc. Canada*, **7**, 145, 438, 441 (1913).
[7] *J. Roy. Astro. Soc. Canada*, **7**, 442 (1913); *J. Brit. Astro. Assoc.*, **24**, 148 (1913).
[8] *Popular Astronomy*, **36**, 398 (1928).

ON the basis of observations accumulated by different authors over the past few decades, I consider that an extra-terrestrial origin of tektites is more compatible with their observed physical and chemical properties. The greatest difficulty encountered by any theory invoking an extra-terrestrial origin of tektites is to explain their peculiar distribution over the surface of the Earth. One would assume that, if tektites had arrived at the Earth in swarms, each swarm would have deposited them over one terrestrial hemisphere, unless the tektites were members of relatively small clouds. Since we observe the tektite deposits to be localized in small regions, we must conclude that the second alternative must be the correct one.

However, a cloud of such particles travelling through space would not retain any degree of compactness for more than a few hours, or perhaps days, and hence the cloud must have originated very near the Earth, possibly at the Moon. To test this hypothesis, I carried out a series of calculations which determined whether material ejected from the Moon by the impact of a meteorite on the lunar surface could arrive at the Earth in such a way as to reproduce the observed distribution of tektites on our planet. The initial conditions of ejection were chosen according to a model of meteoritic impact suggested by Whipple and Rinehart (unpublished work). The computations were carried out on the *IBM* 704 digital computer of the Massachusetts Institute of Technology. The distribution of tektites ejected from a lunar crater so computed agrees remarkably well with the observed distribution of australites (tektites found in Australia), thus making the Moon a very likely source for these peculiar objects.

Details of the calculations have been included in a paper submitted for publication in *Geochimica et Cosmochimica Acta*.

CARLOS M. VARSAVSKY

Harvard College Observatory,
Cambridge 38,
Massachusetts.

THE glassy nature of tektites requires an explanation in terms of the processes of the impact explosions. The heating at a meteoritic impact is very intense, due to the great compression of the meteorite and a comparable quantity of the material of the ground. During the short duration of the event, however, not much heat can be communicated to the surrounding materials. Surfaces can be heated at most to their evaporation temperatures, and the depth to which heat conduction can then cause melting in a few seconds is limited to some millimetres in most substances. The mass ejected from craters is thought to be large compared with that of the meteorites causing them. The suggestion made by O'Keefe to account for the high reflecting power of the 'rays' around the younger lunar craters and also of their interior surfaces would require a large proportion of all this ejected material to be glassy ; and so would the idea of the lunar origin of tektites.

A process that can distribute energy more rapidly than heat conduction through the interior of an opaque solid is required for the explanation, and a large pressure pulse appears to be the only possibility. An impact explosion will no doubt be responsible for a shock wave in the solid. It will, however, be mainly a single pressure cycle, and this can be expected to cause melting only in substances that possess much hysteresis in their compression characteristics. The material must end up as a liquid after the pressure pulse if it is to form beads. Sand or powder of hard rocks would qualify, as there the application and release of high pressure can greatly increase the final density above the initial one. The volume integral of pressure around the cycle representing the work absorbed in the material will then be large. Also the great decrease in the compressibility that will occur

when all the empty spaces have been filled will allow pressure waves of a wide range of intensity to be propagated and to leave similar amounts of energy behind in heat in the material. Without such a sharply non-linear compression characteristic of the material, a shock wave intense enough to produce melting at one range from its focus would produce evaporation at a slightly smaller range, and again only little of the material would be left in liquid form.

On the Earth, the phenomenon of liquefaction by impacts of meteorites in sand has been recognized: the so-called impactites display terrestrial chemical composition, with somewhat similar glassy appearance to the real tektites. But these have occurred in a small fraction of the recognized impact events; where impacts occurred in originally compact materials, only the broken-up forms of these materials seem to have been ejected from the craters.

The present suggested identification of the tektites would allow, therefore, of a judgment concerning not only the chemical but also the physical condition of the lunar surface material. Experimentation with tektite material may allow one to specify more precisely in what state it must have been before the impact. Presumably these considerations go together with the idea that dust covers a large proportion of the lunar surface.

T. Gold

Harvard College Observatory,
Cambridge,
Massachusetts.

A POSSIBLE BASIS FOR PHYTO-IMMUNITY

By D. H. TAYSUM

Rubber Research Institute of Malaya, Kuala Lumpur

In studies on immunity in higher animals the most obvious analytical medium is blood. In plants, however, no such simple standard system is available; indeed, phyto-immunity is, in principle, difficult to formulate because plants have no blood. A variety of natural saps and juices have been suggested as agglutinating systems in previous literature (see, for example, Berridge[1]); the difficulty is to give *a priori* justification to any one system rather than another. What is required is a plant product continuously in contact with (bacterial) infection and demonstrating resistance to this infection over a reasonable portion of the life of the plant (say, 30 years, in the case of a tree). This article suggests that *Hevea* latex is such a system and records its agglutination reactions.

Early in 1956, a sterile box was constructed around a rubber tree (*Hevea brasiliensis*—an unselected seedling), and the latter tapped under aseptic conditions, the air space being irradiated by six ultraviolet germicidal sources (Fig. 1). (Details of this apparatus are to be published elsewhere.) It was found that sterile latex was not initially obtained; the latex vessels harboured bacteria to a depth of about 8 mm. This population could be removed by deep-sectioning. That this type of viable population exists in the vessels of many rubber trees has now been confirmed. It is possible to take latex from the interior of these vessels using a sterile hypodermic syringe and aseptic technique and obtain latex with a viable population of up to 10^5 bacteria/ml.

After each tapping, some 10^{10} viable bacteria develop on the tapping cut; at the following tapping, however, latex with about 10^6 viable bacteria/ml. is obtained, and of this figure some 90 per cent result from random external contamination by bacteria on the outside of the tree. The presence of the indigenous population of latex vessels and the

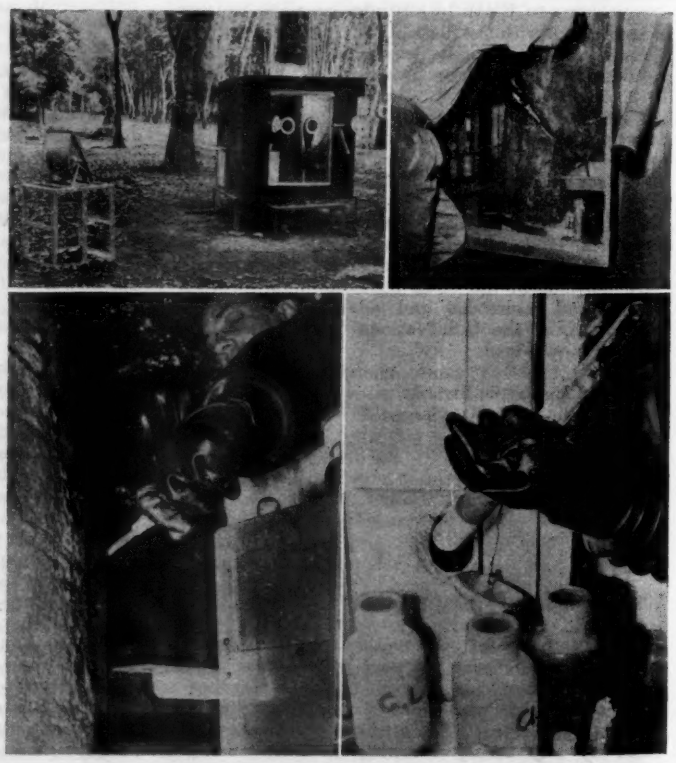
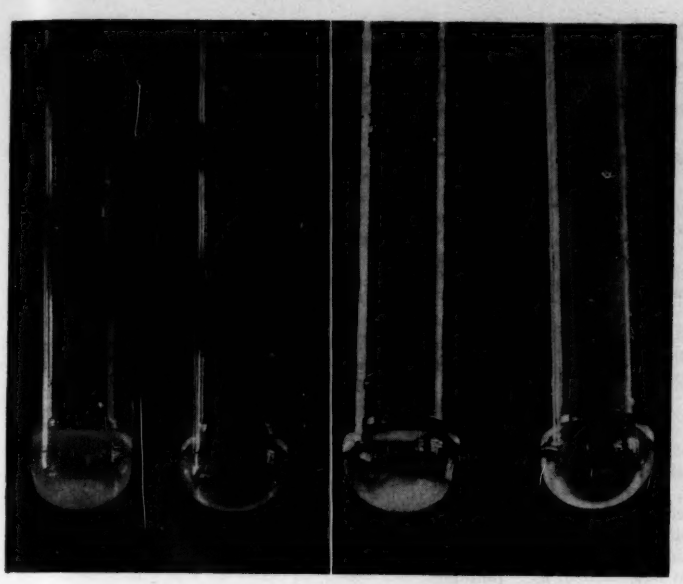


Fig. 1. Apparatus for tapping a seedling rubber tree under aseptic conditions; the sterile cabinet, the tapping operation and the removal of sterile latex in a sterile, sealed container through a dead-space are shown



(*a*) (*b*)

Fig. 2. Agglutination of bacterial suspensions by *Hevea* latex sera (53° C.). (*a*) Control suspension and agglutinated system for *Serratia marcescens* (Bizio). (*b*) Control suspension and agglutinated system for *Micrococcus* sp.

reduction in viable population achieved between tappings argue some powerful defence mechanism designed to limit bacterial attack. The most likely transport for this defence is latex itself (this does not exclude the possibility of a type of phagocytosis occurring elsewhere—say, in the plasma layer). Various types of antigen-antibody reaction could be suggested.

Fig. 2, *a* and *b*, shows agglutination of strains of *Serratia marcescens* (Bizio) and *Micrococcus* sp. both isolated from latex vessels; these are agglutinated by fresh *Hevea* latex sera from known (normal) infected trees, separated by high-speed centrifuging at 20,000 r.p.m. for 30 min. in rotor 40 of the 'Spinco Model *L*' ultracentrifuge (36,000 *g* maximum)[2]; the sera are filter-sterilized. Both somatic and flagellar agglutination are demonstrated by these sera. *H* agglutination takes about 40 min. at 53° C. and *O* agglutination some 8 hr. Despite the relative rapidity of these reactions, the titre is low, and almost neat serum is required for efficient agglutination.

Table 1. Agglutination Reactions in Blood and their Analogues in *Hevea* Latex

Designation	Blood system	*Hevea* latex analogue
Agglutination	Bacterial suspension in saline plus blood serum	Bacterial suspension in saline plus fresh latex serum (from centrifuge)
Hæmagglutination	Bacterial suspension in saline plus red blood cells	Bacterial suspension in saline plus *Hevea* latex hydrocarbon particles (resuspended)
Thomsen–Friedenreich panagglutination and bacteriogenic hæmagglutination	Agglutination of (bacterially) modified red blood cells by sera or other red blood cells (or the converse)	Agglutination of (bacterially) modified hydrocarbon particles by sera or other hydrocarbon particles from *Hevea* latex (or the converse)

In Table 1 are drawn up some normal agglutination reactions for blood, and these are compared to similar reactions obtained for *Hevea* latex.

Since the titre is low, non-specific agglutination might be invoked to explain the simpler reactions—by change of *p*H or by phosphate ion normally present in sera. This view is not favoured: fresh latex is almost neutral, mean *p*H 6·8, and the maximum difference between latices used in these experiments is 0·3 *p*H units; phosphate variations in seedlings are insufficient to explain observed variations in titre. Further, the analogue of bacteriogenic hæmagglutination is a particularly efficient reaction: hydrocarbon particles from virgin trees are rapidly agglutinated (and coagulated) by filter-sterilized infected sera; it therefore follows that some profound modification of these sera must have occurred as a result of previous infection. The difference in agglutination-rates between flagellates and non-flagellates is strong evidence in favour of a specific mechanism.

Of these reactions, those involving modified sera are well defined, there being no difficulty in detecting agglutination by eye; those involving hydrocarbon particles are weak when compared to hæmagglutination. Two factors contribute to this weakness: the first is the very small size of the hydrocarbon particle compared with the red blood cell (0·7μ as against some 8μ—a difference of about two thousand-fold in mass); the second is the low density of hydrocarbon. This means that agglutinated hydrocarbon particles with bacteria may either sediment or float in serum or saline, depending on whether a given clump is composed dominantly of bacteria or hydrocarbon; this does not facilitate macroscopic examination. It is believed that the Thomsen-Friedenreich and related phenomena may explain observations in which latex from newly opened (presumably uninfected) trees suddenly flocculates: contamination of this virgin latex with previously infected hydrocarbon or sera present in the tapping cup would initiate this process.

It is unfortunate that the gross contamination of trees in normal tapping results in these sera being polyvalent. Thus reaction to infection by single strains must be deduced from studies on previously unopened trees, with a resulting limitation in the number of experiments performed. Despite this difficulty, it is thought that these agglutination reactions of *Hevea* latex provide a general tool for the antigenic analysis of bacteria, particularly those pathogenic to plants.

This study forms part of a research programme on the microbiology of *Hevea* latex undertaken by the Board of the Rubber Research Institute of Malaya.

[1] Berridge, E. M., *Ann. App. Biol.*, **16**, 567 (1929).
[2] Cook, A. S., and Sekhar, B. C., *J. Rubber Res. Inst. Malaya*, **14**, 163 (1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electron Spin Resonance of Coals : Saturation Effect

In an investigation into the electron spin resonance of coal, I found a saturation effect depending on the percentage of carbon contained in the coal. The samples, all of them vitrinites, were examined in air ; the frequency at which the measurements were made was 9,000 Mc./s.

It was found that in those cases where the saturation could well be measured the saturation factor Z showed good agreement with the theoretical expectation given by

$$Z = (1 + \tfrac{1}{2}\gamma^2 H_1^2 T_1 T_2)^{-1}$$

In this formula γ is the gyromagnetic ratio, H_1 the amplitude of the alternating magnetic field, T_1 the spin–lattice relaxation time and T_2 the spin–spin relaxation time. As Z, H_1 and T_2 could be experimentally determined, T_1 could be calculated.

Instead of T_1 Fig. 1 gives the variation of $P(Z=0{\cdot}5)$ as a function of the rank. We define $P(Z = 0{\cdot}5)$ as that amount of energy dissipated in one gram of coal, for which the saturation factor Z becomes equal to 0·5. In some cases, for example, when measuring the number of free radicals, this quantity may have a more direct significance to the experimental investigator than the value of T_1.

A variation similar to that in Fig. 1 may probably be expected if for some sugar chars $P(Z = 0{\cdot}5)$ is plotted as a function of the carbonization temperature[1].

From Fig. 1 it is seen that at carbon percentages less than 88 the value of $P(Z = 0{\cdot}5)$ is very low, so that in determining the number of free radicals in this range there is a risk of measuring them in a saturated state and hence of finding a number which is lower than the actual one.

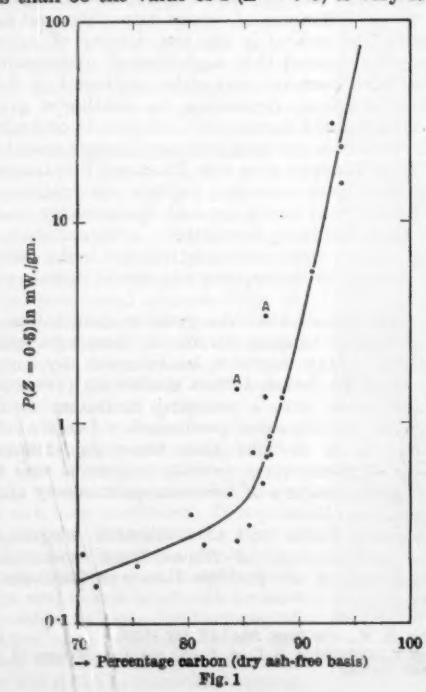


Fig. 1

At carbon percentages greater than 86 the value of $P(Z = 0{\cdot}5)$ shows a rapid increase. Lacking an energy source of sufficient power, I have not been able to measure the saturation effect beyond 94 per cent carbon. That the value of $P(Z = 0{\cdot}5)$ in this range must be very high is corroborated by the facts that a $P(Z = 0{\cdot}5)$-value of 1 mW./gm., for the coal under consideration corresponds to $T_1 \approx 4 \times 10^{-5}$ sec., and that Garif'yanov and Kozyrev[2] measured $T_1 = 12 \times 10^{-5}$ sec. for an anthracite.

I would also direct attention to the influence of ash content. In two cases measurements were made on samples of low and high ash contents (the latter samples are indicated by A in Fig. 1). It is seen that the presence of ash causes a rise of $P(Z = 0{\cdot}5)$. At the same time T_1 decreases, which suggests an increase in the exchange between the unpaired electrons and the surroundings. In both cases the samples of high ash-content proved to contain more free radicals than the practically ash-free samples, which seems to indicate that, at least in the two cases considered, the ash contains paramagnetic components.

J. Smidt

Central Laboratory,
Staatsmijnen in Limburg,
Geleen, The Netherlands.
Nov. 19.

[1] Uebersfeld, J., and Erb, E., *C.R. Acad. Sci., Paris*, **243**, 2043 (1956).
[2] Garif'yanov, N. S., and Kozyrev, B. M., *Zh. Eksper. Teor. Fis.*, **30**, 1160 (1956).

Dispersion Energies in Porous Sorbents

De Boer and Custers[1], by an integration process, approximated to the energy of interaction by dispersion forces between a molecule and several types of cavity. On a plane surface containing N atoms of substrate per cm.^{2} the interaction energy is near to

$$E_1 = -\frac{\pi NA}{6} \times \frac{1}{r^3} \qquad (1)$$

if the interaction energy between an isolated sorbate molecule and the nearest atom of sorbent is given by $-A/r^6$. A is a constant given approximately by the London theory of dispersion forces[2]. Then, in turn, in a hemispherical pocket, at the bottom of a very long cylindrical capillary with a hemispherical end, and in an isolated spherical cavity, all of radius r and just large enough to contain the molecules, the energies of interaction are respectively $E_2 = 4E_1$, $E_3 = 6{\cdot}36E_1$ and $E_4 = 8E_1$.

This calculation indicates that very large maximum enhancements of sorption energies could be expected in suitable capillaries. For two plane parallel surfaces r apart, $E_5 = 2E_1$. Thus, in slit-shaped cavities such as could occur with graphite, the ratio between initial and limiting heats of sorption may approach two. Such a ratio has indeed been observed, and the above explanation of it has been suggested[3]. However, with highly porous sorbents one may easily exaggerate the enhancement of dispersion forces due to environment, and I wish to subject the idea of this enhancement to a more critical examination.

In the first instance the perfect fit of a sorbate molecule into the pocket (energy = E_2), channel

(energy = E_3) or cavity (energy = E_4) will not be encountered in practice. In the nearly spherical cavities in β-quinol, it is true that the free diameter is ~3·9 A., accommodating one argon atom of diameter 3·83 A. neatly[4]. (By 'free' is meant not occupied even by the peripheries of the framework-forming atoms of the lattice.) However, in water clathrates of Type 1, the free diameter is 5·9 A. or 5·2 A.[5] (a 'loose' fit for one argon atom); in chabazite it is ~7·3 A.[6] (three argon atoms just accommodated); in Linde sieve *A* it is ~11·8–11·4 A.[6,7] (filled by thirteen argon atoms); while in faujasite it is ~12–13 A.[6,8,9], filled by eighteen argon atoms. (In the last three sorbents the cavities are also linked by narrower windows into a network of channels, the diameter of which thus varies periodically along their lengths.) Also, and perhaps even more important for such intracrystalline sorptions, a molecule in a cavity is not interacting with a dense atomic distribution outside the cavity, but with a honeycomb-like structure having a rather small density of atoms per cm.³ of sorbent.

One way to demonstrate this last situation is to give per cm.³ of sorbent host-lattice the number N of the atoms of the host lattice. This is done in Table 1, which also gives isosteric heats of sorption at zero coverage and for finite coverage. In column 2 it is seen that N for the important oxygen and carbon atoms of the honeycomb-like sorbents (including β-quinol and the β-ice water lattice in gas hydrates) is only about a third to a quarter of its value in compact solid-sorbents such as rutile or graphite. Thus the value of N in equation 1 is an important factor in *reducing* the enhancement of dispersion forces in these intracrystalline environments. Indeed, E_4 could be reduced by this factor from ~$8E_1$ to ~$2E_1$. If now we compare the situation for argon inside carbon-rich β-quinol with that for argon adsorbed on a non-porous carbon such as the 'Spheron' or 'Graphon' of Table 1 we find ratios of sorption heats E_4/E_1 a little less than two, and very far from the maximum value of eight suggested by de Boer and Custers's treatment. This is despite the nearly perfect fit of argon into the β-quinol cavities. Moreover, when we compare the initial isosteric sorption heats of argon for finely porous 'Saran' carbons with those of non-porous 'Graphon' or 'Spheron' an enhancement is seen for the porous sorbents but only of ~1·5 fold, again much less than the optimum value of eight.

Coming now to the porous oxygen-rich sorbents, chabazite and faujasite, and the dense rutile, it is seen from Table 1 that isosteric heats for argon for larger amounts sorbed are about the same on all three sorbents (polarization energy contributes to initial heats[12], especially for the calcium-rich chabazite crystals, so that the initial heats do not measure only dispersion energies). Evidently, then, the intracrystalline environment of argon in chabazite and faujasite is largely offset by the greater density of oxygen atoms for non-porous rutile, even though the argon is present only on external surfaces of rutile crystals.

Table 1. Some Heats of Adsorption and of Intercalation (kcal./mol.)

Sorbent	N (atoms of sorbent per cm.³) × 10^{-22}	Sorbate	As $v \to 0$	Isosteric heat. For $v/v_m = 0·5$ (or for v (cm.³/gm.) at S.T.P., given by figures in brackets)
β-Quinol (ref. 4)	2·27 (C) 0·76 (O) 2·27 (H)	A*	4·8	4·8
Gas hydrate (ref. 5)	2·66 (H_2O)	A*	~3·0	~3·0
		Kr*	~5·3	~5·3
		Xe*	~8·0	~8·0
Chabazite (ref. 10) (outgassed at 480° C.)	3·0 (O)	A	~6·0	3·0 (50)
		H_2	~3·8	2·0 (40)
Chabazite (ref. 11) (outgassed at 300° C.)		A	4·6	3·6
Faujasite	2·47 (O)	A	2·70	2·70 (25)
		O_2	2·80	2·80 (25)
Rutile (ref. 13)	10·6 (O)	A	3·50	2·50
		O_2	4·00	2·80
Carbon:	11·5 (C as graphite)			
'Spheron' preheated to 2,700° C. (refs. 14–16)		Kr	3·97	4·55
		A	2·70	2·80
		Ne	0·87	0·88
		He	0·37	0·34
'Graphon' (ref. 17)		A	2·60	2·75
'Saran' *S* 84 (ref. 14)		A	3·50	2·63
'Saran' *S*600*H* (ref. 14)		A	3·90	3·63

* Heats for intercalation in β-quinol and in gas hydrate should not depend on amount sorbed. In this case isosteric and integral sorption heats are identical.

Coming now to the porous oxygen-rich sorbents, chabazite and faujasite, and the dense rutile, it is seen from Table 1 that isosteric heats for argon for larger amounts sorbed are about the same on all three sorbents (polarization energy contributes to initial heats[12], especially for the calcium-rich chabazite crystals, so that the initial heats do not measure only dispersion energies). Evidently, then, the intracrystalline environment of argon in chabazite and faujasite is largely offset by the greater density of oxygen atoms for non-porous rutile, even though the argon is present only on external surfaces of rutile crystals.

R. M. Barrer

Physical Chemistry Laboratories,
Imperial College,
London, S.W.7.
Oct. 29.

[1] De Boer and Custers, *Z. phys. Chem.*, B, **25**, 225 (1934).
[2] London, *Z. phys. Chem.*, B, **11**, 222 (1930).
[3] Barrer, *Proc. Roy. Soc.*, A, **161**, 476 (1937).
[4] van der Waals, *Trans. Farad. Soc.* **52**, 184 (1956).
[5] Barrer and Stuart, *Proc. Roy. Soc.*, [A, **243**, 172 (1957)].
[6] Barrer, 10th Solvay Congress, "Quelques Problèmes de Chimie Minérale", Brussels, 21 (1956).
[7] Reed and Breck, *J. Amer. Chem. Soc.*, **78**, 5972 (1956).
[8] Barrer and Sutherland, *Proc. Roy. Soc.*, A, **237**, 439 (1956).
[9] Barrer, Bultitude and Sutherland, *Trans. Farad. Soc.*, **53**, 1111 (1957).
[10] Barrer, *Proc. Roy. Soc.*, A, **167**, 392 (1938).
[11] Garden, Kington and Laing, *Trans. Farad. Soc.*, **51**, 1558 (1955).
[12] Barrer and Stuart (in preparation).
[13] Drain and Morrison, *Trans. Farad. Soc.*, **48**, 840 (1952).
[14] Beebe and Young, *J. Amer. Chem. Soc.*, **58**, 93 (1954).
[15] Amberg, Spencer and Beebe, *Canad. J. Chem.*, **33**, 305 (1955).
[16] Aston and Greyson, in Proc. 2nd Int. Cong. Surface Activity (London, April 1957).
[17] Beebe, Hillard and Cynarski, *J. Amer. Chem. Soc.*, **75**, 839 (1953).

Flame Ionization Detector for Gas Chromatography

A number of gas chromatography detectors depending on ionization of the eluted gases have recently been reported[1]. Ionization has been effected either by β-rays from a radioactive source, or by a low-pressure glow discharge, or by electrons emitted in an ionization gauge.

A sensitive detector has been developed which depends on the ionization of the effluent in a hydrogen flame. A schematic diagram of the detector is shown in Fig. 1. The gases from the column in a suitable inert carrier are mixed with hydrogen, and burned in air at the tip of the glass jet. If hydrogen is used as the carrier gas, mixing is naturally unnecessary. The platinum electrodes are arranged to be in contact with the flame, the spacing being not very critical.

The electrical circuit used, Fig. 2, consists of a balanced cathode-follower impedance transformer. With a 0–1 m.amp. meter or recorder connected to the output terminals, full-scale deflexion was

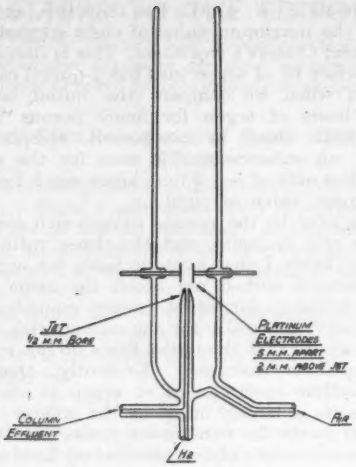


Fig. 1

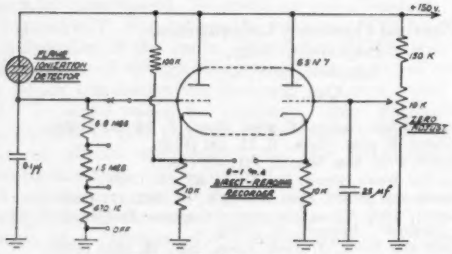


Fig. 2. Electrical circuit

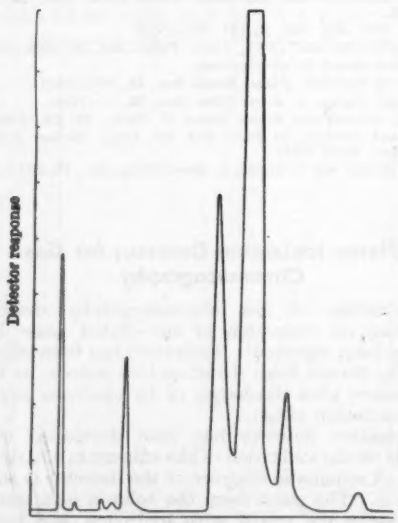


Fig. 3. Analysis of Japanese mint oil. Column packing: 'Celite' and di-nonyl-phthalate. Sample size, 5λ. Column temperature, 170° C.

produced with an injected sample of 1 μl., with a signal-to-noise ratio of better than 1,000 to 1, and no observable base-line drift over a wide range of operating conditions. The ultimate sensitivity of this detector has not yet been established.

A typical chromatogram using this detector is shown in Fig. 3. The electrical output appears to depend linearly on the sample size and was tested up to 10 μl., the reproducibility being at all times limited only by injection precision.

As the detector is constructed entirely of glass and metal, it is well suited to the detection of fractions from high-temperature columns.

A more detailed description of the detector will be published shortly.

J. Harley

Engineering Research Section,
South African Iron and Steel
Industrial Corporation, Limited,
Pretoria.

W. Nel
V. Pretorius

Department of Physical Chemistry,
University of Pretoria.

[1] Otvens, J. W., and Stevenson, D. P., *J. Amer. Chem. Soc.*, **78**, 546 (1956). Harley, J., and Pretorius V., *Nature*, **178**, 1244 (1956). Ryce, S. A., and Bryce, W. A., *ibid.*, **179**, 541 (1957).

Electric Double Hysteresis in $(K_x Na_{1-x})NbO_3$ Single Crystals

Sodium niobate forms solid solutions of perovskite type structure with the niobates of potassium[1], cadmium[2] and lead[3]. At quite low concentrations of the latter in these compositions the room temperature orthorhombic antiferroelectric structure of pure sodium niobate ($NaNbO_3$) gives place to an orthorhombic ferroelectric form. The phase-change between these two structures has not, however, been observed in any of these systems. In the ceramic specimens which have been examined, the ferroelectric properties increase gradually over a range of compositions. Pure sodium niobate single crystals, on the other hand, show double hysteresis loops at high fields[4] suggesting a discontinuous change to a ferroelectric form.

Using the techniques previously developed for sodium niobate, I have now extended the single-crystal measurements to the system $(K_x Na_{1-x})NbO_3$, and find the following properties. The phase diagram, determined optically on a hot-stage polarizing microscope, is shown in Fig. 1. The behaviour of specimens in both regions *a* and *b* is characteristic of orthorhombic crystals of cubic habit, with twinned regions showing parallel and symmetric extinction, and there is no qualitative optical distinction between them. The refractive indices and birefringence are, however, different in *a* and *b*, so that the phase change in a single crystal may be readily distinguished. The lines 1, 2, represent extreme cases of the survival of phase *b* in *a*, and vice versa, and it is probable that the two phases co-exist over the whole region *ab*.

Crystals of pure sodium niobate show electric double hysteresis for fields greater than 90 kV./cm. perpendicular to the orthorhombic *c*-axis. With increasing potassium niobate content, the field required to initiate hysteresis in the mixed crystals is continuously reduced, and the halves of the double loop commence to overlap. As the composition approaches the boundary 1 on Fig. 1 (in the region of 0·6 mole per cent potassium niobate), the electrical properties become more complex and markedly

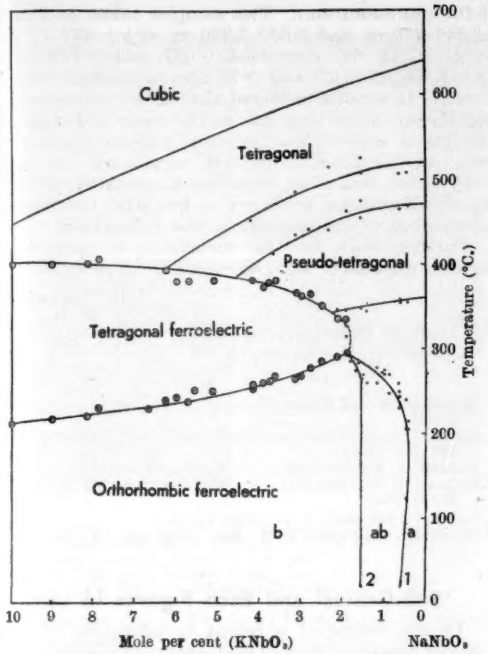


Fig. 1. Phase diagram for mixed $(K_xNa_{1-x})NbO_3$ crystals

dependent on pre-treatment. In virgin crystals, $P \propto E$ is approximately linear up to a critical field-strength of the order of 20 kV./cm. at 50 c./s. Above this value, the initial cycles of the field produce double hysteresis loops, but subsequent cycling rapidly produces a ferroelectric loop (Fig. 2). Normal hysteresis persists below the previous critical field strength, and the performance of the virgin crystal is only regained after a sufficient period free from external fields. The time taken to recover varies widely between different specimens, but generally appears to increase as the composition approaches the phase boundary. With compositions containing more than 0·6 mole per cent potassium niobate, the mixed crystals give ferroelectric hysteresis loops.

These measurements confirm the discontinuous nature of the phase transition between antiferroelectric and ferroelectric orthorhombic structures in the $(K_xNa_{1-x})NbO_3$ system of solid solutions. The two structures, however, coexist over a considerably wider range of temperature than has been evident in any previously observed phase-change in a perovskite material.

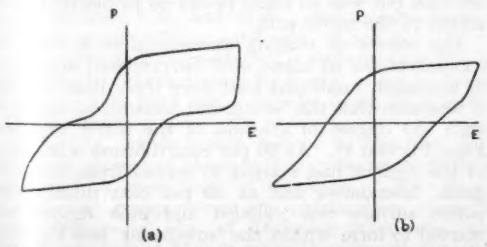


Fig. 2. Electric hysteresis in a single crystal of composition $(K_{0\cdot505}Na_{0\cdot495})NbO_3$. (*a*) Initial application of 42 kV./cm. at 50 c./s. perpendicular to the orthorhombic *c*-axis; (*b*) 40 kV./cm. at 50 c./s. 1 hr. after cycling with 50 kV./cm. at 50 c./s.

There are a number of possible explanations for the absence of any discontinuity in the electrical properties of the equivalent ceramic materials. For compositions close to $NaNbO_3$, the single-crystal loops show that the field required to change the spontaneous polarization is high. There is also some evidence that the 'coercivity' increases with decreasing specimen thickness; thus with the distribution of orientations, and small crystallite size in the ceramics, it may not be possible to produce polarization re-orientation until the composition is markedly ferroelectric. It is probable also that there are larger composition inhomogeneities in the ceramics than in the single crystals, again tending to smear out the transition.

The very close proximity of the ferroelectric *b* phase to the pure sodium niobate makes it appear likely that similar phase-changes exist in the cadmium and lead systems. It is doubtful, however, whether the phase boundaries will be detected without a systematic investigation of single crystals of these materials.

A more complete account of this work, and the correlation with the thermodynamic treatment[5] of the properties of the solid solution sequence will be published elsewhere.

I am indebted to the Director of the British Electrical and Allied Industries Research Association for permission to publish this communication.

L. E. Cross

The Electrical Research Association Laboratory, Cleeve Road, Leatherhead, Surrey.

[1] Shirane, G., Newnham, R., and Pepinsky, R., *Phys. Rev.*, **96**, 581 (1954).
[2] Lewis, B., and White, E. A. D., *J. Electronics*, **1**, 646 (1956).
[3] Lewis, B., and Fancombe, M. H., *J. Electronics*, **2**, 387 (1957).
[4] Cross, L. E., and Nicholson, B. J., *Phil. Mag.*, **46**, 212 (1955).
[5] Cross, L. E., *Phil. Mag.* **1**, 76 (1956).

Germanium and Gallium in Sea-Water

Germanium

No quantitative data have so far been published for the concentration of germanium in sea-water. The first observation of germanium in a specimen of marine origin was due to Cornec[1], who detected it spectrographically in the ash of *Laminaria* sp. Noddack and Noddack[2] found the element in nine widely differing marine organisms in amounts ranging from 0·07 to 2·2 p.p.m. They were unable to detect it in sea-water, and concluded that its concentration must be less than 0·1 μgm./l. Bardet *et al.*[3] attempted to co-precipitate a number of trace elements from 60-l. samples of sea-water from Roscoff (Brittany) using seven different carriers; spectrographic examination of the precipitates revealed the presence of germanium in three cases.

Buljan[4] and Ishibashi and Shigematsu[5] have attempted to predict the abundances of the elements in sea-water, and have arrived at the values of 73 and 0·2 μgm./l. respectively for the concentration of germanium. The former figure is obviously much too high, since it would give a silicon : germanium ratio in sea-water of about 20 : 1 as compared with a ratio of about 140,000 : 1 in the lithosphere (Riley, J. P., and Burton, J. D., unpublished work).

In order to get some quantitative information on the concentration of germanium in sea-water, 5-l. samples of sea-water were treated with ferric alum

solution. The resultant precipitate of ferric hydroxide, which carried down more than 97 per cent of the germanium present in the sea-water, was dissolved in concentrated hydrochloric acid. Germanium was extracted from the acid solution with carbon tetrachloride, back-extracted with water and determined spectrophotometrically with phenylfluorone.

Surface samples of water from the Irish Sea (2), the English Channel (4) and the North Atlantic (2) were found to contain 0·06 ± 0·01 μgm. of germanium/kgm. (0·82 ± 0·13 μgm.-atom/ton). Samples taken at depths of 240–270 m. and 3,660–3,900 m. at lat. 47° 47′ N., long. 9° 18′ W., contained 0·06 and 0·07 μgm./kgm. (0·82 and 0·96 μgm.-atom/ton) respectively. The average germanium concentration found is of the same order as that predicted by Ishibashi and Shigematsu[5]. Germanium is concentrated in sea-water, relative to the closely related element silicon, having a silicon : germanium ratio of about 17,000 : 1 (assuming a silicon concentration of 1,000 μgm. silicon/l., which is probably considerably higher than average); compared with a ratio of about 140,000 : 1 in the lithosphere. The concentration of the element in sea-water is much more constant than that of silicon, which varies[6] over the range 10–2,500 μgm./kgm. This constancy is probably attributable to the fact that, unlike silicon, it is not utilized appreciably by plankton.

Further work is in progress on the marine geochemistry of germanium.

J. D. Burton
J. P. Riley

[1] Cornec, E., *C.R. Acad. Sci., Paris*, **168**, 513 (1919).
[2] Noddack, I., and Noddack, W., *Ark. Zool.*, **32**, 1 (1940).
[3] Bardet, J., Tchakirian, A., and Lagrange, R., *C.R. Acad. Sci., Paris*, **206**, 450 (1938).
[4] Buljan, M., *Acta Adriat.*, **4**, No. 6, 36 (1949).
[5] Ishibashi, M., and Shigematsu, T., *Bull. Inst. Chem. Res. Kyoto Univ.*, **27** 42 (1951).
[6] Harvey, H. W., "The Chemistry and Fertility of Sea-Waters", 147 (Cambridge Univ. Press, 1955).

Gallium

Little is known of the occurrence of gallium in sea-water. Its presence was first detected by del Campo and Rodeja[1]. Bardet *et al.*[3] found it spectrographically, together with thirteen other trace elements, in water samples taken near Roscoff (Brittany). The only quantitative data so far published are due to Noddack and Noddack[3], who found 0·5 μgm. of gallium/l. in the water of Gullmars Fjord, Göteborg, Sweden; this analysis can scarcely be considered representative of ocean water, since the sample was taken from a fjord which is likely to be contaminated by drainage from the land. Ishibashi and Shigematsu[4] have predicted the abundance of gallium in sea-water to be 0·005 μgm./l.

The present communication records an attempt to obtain quantitative data on the occurrence of gallium in sea-water. The element was precipitated in 93 ± 5 per cent yield from 5-l. samples of filtered sea-water using ferric hydroxide as carrier. The ferric hydroxide precipitate was dissolved in hydrochloric acid, titanous chloride was added to reduce the iron to the ferrous state, and gallium was then extracted with di-*iso*-propyl ether. After evaporation of the ether, gallium was determined spectrophotometrically in the residue, using a modification[5] of the rhodamine *B* method of Onishi and Sandell[6].

Samples of the surface waters of the Irish Sea (4), the English Channel (1), and North Atlantic (2) contained 0·030 ± 0·007 μgm. gallium/kgm. (0·43 ± 0·10 μgm.-atom/ton). Two samples taken at depths of 240–270 m. and 3,660–3,900 m. at lat. 47° 47′ N., long. 9° 18′ W. contained 0·037 and 0·023 μgm. gallium/kgm. (0·53 and 0·33 μgm.-atom/ton) respectively. It is not considered that these variations are significant, since they are of the same order as the analytical error. The average gallium content of sea-water is thus about 0·03 μgm./kgm.—a value very much less than that found spectrographically by the Noddacks, but more in line with the relative abundance of the element in the lithosphere.

Further work on the occurrence of gallium in marine organisms and sediments is in progress.

F. Culkin
J. P. Riley

Dept. of Oceanography,
University, Liverpool, 3.
Sept. 13.

[1] del Campo, A., and Rodeja, V. G., *Anal. soc. esp. fis. quim.*, **12**, 78 (1914).
[2] Bardet, J., Tchakirian, A., and Lagrange, R., *C.R. Acad. Sci., Paris*, **206**, 450 (1938).
[3] Noddack, I., and Noddack, W., *Ark. Zool.*, **32**, 1 (1940).
[4] Ishibashi, M., and Shigematsu, T., *Bull. Inst. Chem. Res. Kyoto Univ.*, **27**, 42 (1951).
[5] Culkin, F., and Riley, J. P. (in the press).
[6] Onishi, H., and Sandell, E. B., *Anal. Chim. Acta*, **13**, 159 (1955).

'Sub-Grains' and Etch Figures in Lead

In the course of a recent investigation into the ageing characteristics of lead–antimony alloys[1], microscopical examinations of a range of aged specimens were carried out and recrystallized areas were observed in a number of the specimens which had been strained prior to ageing. The specimens had been prepared by the normal metallographic techniques of grinding and polishing and had been etched in Worner and Worner's reagent[2] to disclose the extent of precipitation. In a number of the specimens the precipitated antimony was cleared from the surface by a brief immersion in concentrated nitric acid (s.g. 1·42) and subsequent examinations showed the recrystallized areas to be covered with networks of fine lines producing an appearance of sub-grains, similar to that due to polygonization, which had been absent from the specimens prior to the nitric acid treatment.

Specimens of unalloyed lead which were given the same etching treatment were found to show this structure over their entire surfaces even in cast material, and modifications in straining and annealing procedure did not produce changes in sub-grain dimensions. Repeatedly re-etching the same area of a single specimen did not develop the same configuration of sub-grains, and it was concluded that the network of lines did not result from the structure of the lead but was an effect produced primarily by the action of the nitric acid.

The effects of etching treatments in a range of concentrations of nitric acid on prepared specimens of annealed, unalloyed lead were then observed and it was seen that the 'sub-grain' dimensions increased with the degree of dilution of the nitric acid (see Figs. 1 *a* and *b*). At 20 per cent dilution a mottling of the surface had started to spread from the 'sub-grain' boundaries and at 30 per cent dilution the entire surface was mottled and etch figures had started to form within the 'sub-grains' (see Fig. 1 *c*). These etch figures continued to develop to the extent shown in Fig. 1 *d* by treatment in nitric acid diluted 40 per cent.

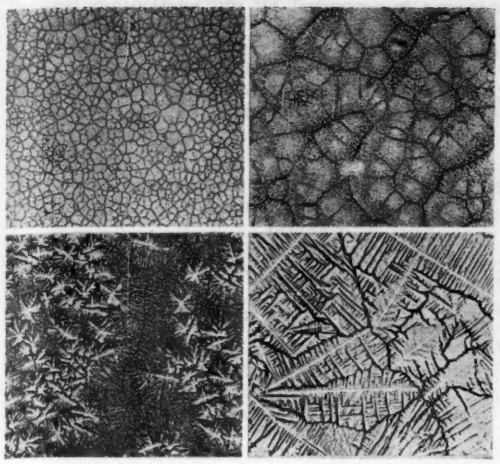


Fig. 1. *a*, Pure lead, treated in Worner and Worner's reagent and then in concentrated nitric acid, s.g. 1·42; *b*, as *a*, but finally treated in nitric acid, diluted 20 per cent; *c*, as *a*, but finally treated in nitric acid, diluted 30 per cent; *d*, as *a*, but finally treated in nitric acid, diluted 40 per cent. (All × 300)

Thanks are due to Mr. A. F. Lampitt, director and general manager of Southern United Telephone Cables, Ltd., for permission to publish this communication.

E. J. Hooker

Southern United Telephone Cables, Ltd.,
Dagenham Dock, Essex.
Oct. 30.

[1] Hooker, E. J., *J. Inst. Metals*, **86**, 98 (1957–58).
[2] Worner, H. W., and Worner, H. K., *J. Inst. Metals*, **66**, 45 (1940).

Anomalous Atmospheric Refraction at Sea

During the Atlantic crossing on Research Yacht *Princess Waimai* in 1954, to increase the accuracy of navigation astronomical sights were taken, as a rule, in series of observations: the noon sight series, extending usually for about an hour, with the Sun's culmination in its middle, 9 a.m. and 3 p.m. series, extending for about 20 min. Observations were taken about every minute. In all, 46 noon sight curves were obtained and 72 others, all in good weather conditions, within the tropics. The sextant used was a Henry Hughes instrument, with a recent class *A* National Physical Laboratory certificate. The height of the eye varied for different series of sights between 6 ft. and 10 ft.; estimated accuracy of observations within $\pm 0{\cdot}5$ min. of arc.

Considering all the material, it appears that 24 per cent of sight points deviate by 2 min. of arc or more, and $\frac{1}{2}$ per cent by 5 min. of arc or more, from interpolated curves.

Deviating points rarely appear at random, but rather in groups of three to five consecutive points, showing the same sign of deviation. But when a deviating group covers the culmination, there is often change of sign of deviation when the culmination is passed, that is, when the azimuth changes very quickly and the telescope sweeps over large stretches of the horizon between two consecutive sights. Groups of points deviating on either side of the curve are equally frequent. Morning sights show the lowest deviation frequency, namely, 15 per cent. There is little difference in frequency between noon and afternoon sights.

A plausible explanation of this phenomenon seems to be fluctuations of horizon height due to anomalous atmospheric refraction.

Some experiments have also been devoted to sextant optics. It was found that polarizing optics are superior to standard coloured glass 'shades', with which the sextant is normally equipped. Such optics often allow better horizon definition and also provide continuity in dimming incoming light. A 'Polaroid' disk, attached to one end of a sextant telescope so that it could be rotated, and another one, also with free rotation, in place of standard sun 'shades', was used. By rotation of the telescope 'Polaroid' one obtains the horizon contrast, and then the rotation of the sun 'Polaroid' provides the continuity in dimming the Sun. As any glare coming from the sea surface can be cut out completely by the telescope 'Polaroid', there is little need for additional horizon 'shades'; but, if desired, a third 'Polaroid', also with free rotation, can be attached in their place.

B. M. Cwilong

Research Yacht *Princess Waimai*,
Balboa, Panama Canal Zone.
Sept. 17.

Effect of the Metallic Ion on the Infra-Red Spectra of Salts of Carboxylic Acids

A full analysis of the infra-red spectra of salts of carboxylic acids requires an interpretation of the effect of the metallic ion. Although a theoretical study of the formate ion has been published, a fundamental investigation of the perturbation caused by the presence of the metal ion has not yet been attempted[1]. Therefore, at present it is necessary to rely on empirical correlations.

The strong absorption bands attributed to the unsymmetrical (ω_2 at 6·2–6·6μ) and symmetrical (ω_1 at 7·1–7·7μ) vibrations of the carboxylate ion (COO^-) have been the most thoroughly investigated[2].

Recently, Kagarise[3] reported that for mono- and di-valent metals there are linear relationships between electronegativity and wave number of the ω_2 band for eight metallic phenyl stearates. Theimer and Theimer[4] have claimed that there is a relationship between the ionic radius of the metal and the Raman ω_1 band for the salts of five fatty acids.

The relationships claimed by Kagarise must not be regarded as general. Preliminary results on eight

Table 1

Metal	Electro-negativity	Ionic charge	Radius (A.)	Wave-length of ω_2 band (μ)*
Li	1·0	+	0·78	6·348 (*S*); 6·442 (*M*)
Na	0·9	+	0·98	6·362 (*S*); 6·421 (*W*); 6·503 (*S*)
Mg	1·2	++	0·78	6·368–6·386 (*S*) broad band
K	0·8	+	1·33	6·415 (*S*)
Ca	1·0	++	1·06	6·362 (*S*); 6·510 (*S*)
Zn	*c.* 1·6	++	0·83	6·510 (*S*)
Ba	0·9	++	1·43	6·625 (*S*)
Pb	—	++	1·32	6·627 (*S*)

* The spectra were determined in 'Nujol' mulls with a Grubb Parsons double-beam infra-red spectrometer, with rock salt optics. Strength of band: *S*, strong; *M*, medium; *W*, weak.

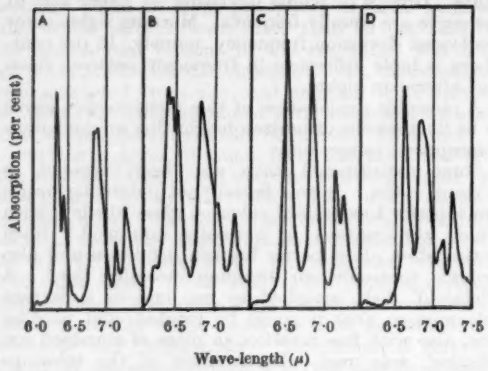


Fig. 1. Spectra of metal stearates (determined in 'Nujol' mulls). *A*, Lithium stearate; *B*, sodium stearate; *C*, zinc stearate; *D*, barium stearate

metallic stearates show that the effect of the metallic ion may be more complicated than a simple change in frequency of the ω_2 carboxylate band (see Table 1 and Fig. 1). The splitting of this band into a doublet (lithium and calcium) and a triplet (sodium) requires further investigation.

The influence of the metal ion may not be simply related to any one single factor. However, inspection of Table 1 shows that there is no relationship for these metallic stearates between the wave-length of the ω_2 band and either the electronegativity or the ionic radius of the metal.

For the eight metallic stearates investigated the dominant influence of the mass of the metal in determining the perturbation of the ω_2 carboxylate band is clearly illustrated in Fig. 2. However, because of the occurrence of doublets and triplets it is not possible to determine a single relationship between the wave-length of the ω_2 band and the mass of the metal ion.

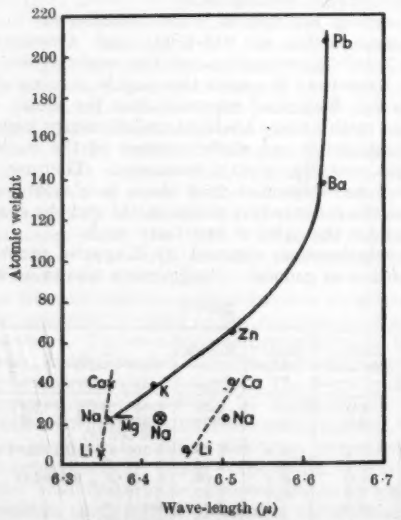


Fig. 2. Atomic weight versus wave-length of ω_2 carboxylate band for metallic stearates. ●, Single absorption band; × shorter wave-length of doublets; ○, longer wave-length of doublets; ◐, intermediate weak peak (sodium stearate); —, broad band (magnesium stearate)

The dependence on mass noted here for metallic stearates is supported by the relationship between mass and frequency found in the spectra of carbonates[5] and metallic acetyl acetonates[6].

The award of a Research Fellowship to one of us (B. E.) by the Imperial Smelting Corporation, Limited, is gratefully acknowledged.

Bryan Ellis
H. Pyszora

National College of Rubber Technology,
Northern Polytechnic,
Holloway,
London, N.7.

[1] Davis, M., and Orville-Thomas, W. J., *Disc. Farad. Soc.*, **9**, 335 (1956). Orville-Thomas, W. J., private communication.
[2] Bellamy, L. J., "The Infra-red Spectra of Complex Molecules", 149 (Methuen, London, 1954).
[3] Kagarise, R. E., *J. Phys. Chem.*, **59**, 271 (1955).
[4] Theimer, R., and Theimer, O., *Monatsh.*, **81**, 313 (1950).
[5] Miller, F. A., and Wilkins, C. H., *Anal. Chem.*, **24**, 1253 (1952).
[6] Jones, R. N., and Sandorfy, C., "Techniques of Organic Chemistry", **9**, 556 (Interscience, New York, 1956).

A New Class of Antibiotic Salts of Reduced Toxicity

We have recently reported[1] the preparation and acute toxicity of a number of salts of basic antibiotics with acid vitamins. However, the good results obtained with the pantothenates in the reduction of the neurotoxicity of streptomycin[2,3] have not been as marked in the prevention of nephrotoxicity and other side effects produced by neomycin[4] and viomycin[4,5]. This prompted us to prepare other types of salts of antibiotics.

It was Short[6] who first reported that methionine and S-methyl-L-cysteine reduced the nephrotoxicity of polymyxin A. Kimmerle and Gösswald[7] showed that N-acetylmethionine reduced the toxicity of streptomycin and briefly mentioned that the leucinate of the same antibiotic had no advantage over the sulphate. We record here the preparation of amino-acid salts of basic antibiotics that may prove of interest not only in the general reduction of toxicity but also in the detoxication of specific organs.

The dihydrostreptomycin salts were prepared by neutralization of concentrated aqueous solutions of the base with three moles of the amino-acid or by double decomposition between solutions of dihydrostreptomycin sulphate and of an equivalent quantity of the proper barium amino-salt. The salts were then obtained by freeze-drying the solutions or concentrating them under reduced pressure at room temperature, dissolving the syrup in methyl alcohol and precipitating with a ten-fold excess of acetone. The tri-salts are stable in the solid state. They are very soluble in water giving solutions slightly alkaline except when the amino-group is acylated. The following salts were prepared: Glycinate (Anal. Calc. for $C_{27}H_{54}N_{10}O_{16}$: C, 40·09; H, 6·98; N, 17·32; Found: C, 39·99; H, 7·14; N, 17·15); DL-leucinate (Anal. Calc. for $C_{39}H_{80}N_{10}O_{16}$; C, 47·94; H, 8·25; N, 14·34. Found: C, 47·78; H, 8·45; N, 14·09); L-glutamate (Anal. Calc. for $C_{36}H_{66}N_{10}O_{24}$: C, 42·18; H, 6·69; N, 13·67. Found: C, 42·40; H, 6·97; N, 13·40); L-methioninate (Anal. Calc. for $C_{36}H_{74}N_{10}O_{16}S_2$: C, 41·93; H, 7·23; N, 13·58. Found: C, 42·16; H, 7·61; N, 13·47); N-acetyl-DL-methioninate (Anal. Calc. for $C_{48}H_{90}N_{10}O_{21}S_2$: C, 43·58; H, 6·97; N, 12·10. Found: C, 43·42; H, 6·94; N, 11·80) and S-ethyl-L-cysteinate (Anal.

Table 1. Acute Intravenous Toxicity of Salts of Dihydrostreptomycin

Salt	Potency γ base/mgm.	LD50 mgm. base/20 gm.
Glycinate	721	3·38
DL-Leucinate	597	3·94
L-Glutamate	569	3·74
L-Methioninate	566	4·12
N-Acetyl-DL-methioninate	504	3·32
S-Ethyl-L-cysteinate	566	3·17
Sulphate	799	3·18
Ascorbate (ref. 1)	524	4·55
Pantothenate	470	3·80
Glucuronate	500	3·24

Calc. for $C_{36}H_{74}N_{16}O_{18}S_3$: C, 41·93; H, 7·23; N, 13·58. Found: C, 41·28; H, 7·58; N, 13·50).

The acute intravenous toxicities determined in white mice are shown in Table 1, which includes for comparison the sulphate, pantothenate, ascorbate and glucuronate (prepared by a method similar to U.S. Patent 2,583,534, December 31, 1949).

The acute toxicities are, in most cases, lower than those of the sulphate or glucuronate except the S-ethyl-L-cysteinate in which, however, the anion also has tuberculostatic activity[8]. The leucinate and the methioninate are being studied further. These are less toxic than the pantothenate, and only the ascorbate is less toxic than they.

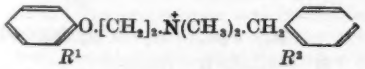
F. A. Alves
M. F. C. A. N. Graça
H. L. Baptista

Research Laboratories,
Laboratorios Atral,
Lisbon.

[1] Alves, F. A., and Graça, M. F. C. A. N., papers presented to the 23rd Congress of the Spanish-Portuguese Association for the Advancement of Science, Coimbra, June 1956, and to the 2nd Pakistan Pharmaceutical Conference, Karachi, November 1956; Belgian Patent 552140 (May 1957).
[2] Keller, H., Krüpe, W., Sous, H., and Mückter, H., *Arzneimittel-Forsch.*, **5**, 170 (1955).
[3] Neves de Almeida, F., and Neves de Almeida, J. M., *O Médico*. (Lisbon), **3**, 1131, 1329 (1955).
[4] Keller, H., Krüpe, W., Sous, H., and Mückter, H., *Arzneimittel-Forsch.*, **6**, 61 (1956).
[5] Koch, J., *Schweiz. med. Wochschr.*, **86**, 413 (1956). Kuntz, E., *Arzneimittel-Forsch.*, **7**, 233 (1957).
[6] Short, E. I., *Brit. J. Pharmacol.*, **7**, 248 (1952).
[7] Kimmerle, G., and Gösswald, R., *Arzneimittel-Forsch.*, **6**, 379 (1956).
[8] Brown, H. D., Matzuk, A. R., Becker, H. J., Conbere, J. P., Constantin, J. M., Solotorovsky, M., Winsten, S., Ironson, E., and Quastel, J. H., *J. Amer. Chem. Soc.*, **76**, 3860 (1954).

A New Series of Anthelmintics

We wish to report a new series of chemical compounds effective against nematodes parasitic in the gastro-intestinal tract of mammals. Certain of these compounds possess an unusually broad anthelmintic spectrum which includes appreciable activity against certain species causing infections of economic importance for which there is, at present, no satisfactory treatment.



(I)

These compounds (patent applications pending) have the general formula (I), where R^1 can be hydrogen, methyl or chlorine, while R^2 can be hydrogen, methyl, chlorine or fluorine. Lower activities are encountered when R^1 is a nitro-group, bromine or when R^2 is bromine. Numerous other variants are in course of examination.

The synthesis and initial biological assay of the series were carried out by two of us (F. C. C. and O. D. S.). *Nippostrongylus muris* was used as the test organism in this work. Afterwards, biological testing was extended to observe the effects of the more active compounds against trichostrongylid nematodes in sheep, *Uncinaria stenocephala* in dogs (J. S. and D. A. R.) and *Ancylostoma caninum* in dogs and cats (R. B. B.) as well as other species of nematodes cultured in small laboratory animals.

Certain members of the series possess anthelmintic activity against a wide range of species. It is of particular interest that these compounds appear to be more effective against the mucosa-dwelling species of parasitic nematode than against those living more freely in the lumen. Thus, considerable activity has been demonstrated against *N. muris* in the rat; *Nematospiroides dubius* in the mouse; *Nematodirus* sp., *Haemonchus contortus*, *Trichostrongylus axei*, *Cooperia curticei* and *Ostertagia* spp. in the sheep; *A. caninum* in the dog and cat. Lower activity has been demonstrated against *U. stenocephala*, *Aspiculuris tetraptera*, *Syphacea obvelata*, *Toxocara canis*, *T. cati*, *in vivo* and against *Ascaris lumbricoides* (from the pig), *in vitro*. The full range of activity has yet to be established. Field trials are in progress, and clinical trials are to be undertaken.

F. C. Copp

Wellcome Chemical Research
Laboratories,
Beckenham, Kent.

O. D. Standen

Wellcome Laboratories of
Tropical Medicine,
London.

J. Scarnell
Deirdre A. Rawes

Wellcome Veterinary Research
Station,
Frant, Sussex.

R. B. Burrows

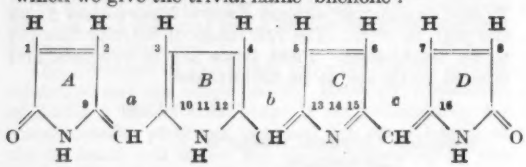
Wellcome Research Laboratories,
Tuckahoe, New York.

The IX-α Structure of the Common Bile Pigments

It is generally accepted that all the naturally occurring 'tetrapyrrolic' bile pigments must be of a IX-α structure, that is, that they are derived from the biliverdin which is produced biologically by rupture of the α-methene bridge carbon atom of protoporphyrin IX. Therefore, all bile pigments prepared from biological material should possess a 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-divinyl (or diethyl), open-chain, 'tetrapyrrolic' structure (using the system of numbering shown in formula (I). Although some of the bile pigments have been synthesized by methods which exclude the formation of isomers other than IX-α, there is, at present, no analytical evidence of the absence of such isomers in the pigments obtained from biological sources. The presence of such isomers would be expected if biological fission of the protoporphyrin molecule did not occur exclusively at the α-methene linkage. Since stercobilin (and therefore also the less-hydrogenated bile pig-

ments) is known to be produced by at least two distinct physiological mechanisms[1], such a possibility is not entirely speculative. The method of identification of pyrrole carboxylic acids described by one of us and used in investigations of the porphyrins[2] has now been applied to a study of the order of the β-side-chains of the bile pigments. In the bile pigments one α-position of each end ring bears an oxygen atom (usually formulated in a hydroxyl group[3]) instead of a carbon atom. It is therefore impossible for these rings, on degradation, to provide the αα′-pyrroledicarboxylic acids given under similar conditions by the corresponding porphyrins; any such acids can only originate from the middle rings of the pigment molecule.

The 'hydroxypyrroles' in general, and particularly those used in the syntheses of the bile pigments, are in fact pyrrolenones[4], and it is therefore probable that the bile pigments are also lactam compounds. The present systems of nomenclature[5] make no provision for this fact and do not allow easy derivation of the structures of the bile pigments. In this communication we have named the bile pigments as derivatives of the fully unsaturated structure I, to which we give the trivial name 'bilenone'.



(I)

The bile pigments are derived from I by appropriate substitution at positions 1–8 and by suitable reduction of any of the carbon–carbon double bonds shown with the exception of those in the two middle rings *B* and *C*. Rings *B* and *C*, together with the linking methene group, *b*, are assumed to constitute a resonating dipyrrylmethene unit; reduction of this by means of two atoms of hydrogen produces a dipyrrylmethane structure in which rings *B* and *C* are truly pyrrolic. The systematic names which result from the use of this system of nomenclature have been used in Table 1.

Table 1

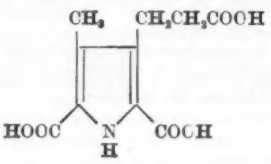
Compounds oxidized	Acids obtained II	III	IV
Bilirubin 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-divinyl-(*b*-13)-dihydrobilenone	++	–	–
Mesobilirubin 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-diethyl-(*b*-13)-dihydrobilenone	++	–	–
Biliverdin 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-divinyl-bilenone	++	–	–
Mesobiliviolin* 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-diethyl-(*c*-16) dihydrobilenone	++	–	–
***d*-Urobilin † (ref. 7)** 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2 (or 8)-ethyl-8-(or 2)-vinyl-(9-*a*),(*c*-16)-tetrahydrobilenone	+	—	–
Stercobilin 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-diethyl-(1-2),(9-*a*),(*c*-16),(7-8)-octahydrobilenone	–	–	–
Glaucobilin 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-diethyl-bilenone	++	–	–
Stercobilinogen 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-diethyl-(1-2),(9-*a*),(*b*-13),(*c*-16),(7-8)-decahydrobilenone	–	–	–
Mesobilirubinogen 1,3,6,7-tetramethyl-4,5-dicarboxyethyl-2,8-diethyl-(9-*a*),(*b*-13),(*c*-16)hexahydrobilenone	+	–	–
Glaucobilin-XIII-α 1,3,6,8-tetramethyl-4,5-dicarboxyethyl-2,7-diethyl-bilenone	++	–	–
2,4-dimethyl-3-carboxyethylpyrrole-5-carboxylic acid	–	–	–

* Probably a mixture of mesobilirhodin and mesobiliviolin
† The positions of the ethyl- and vinyl-groups are not yet known with certainty.

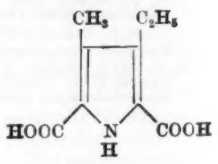
About 30 mgm. of each of the bile pigments mentioned in Table 1 were oxidized with alkaline potassium permanganate and the products were identified by chromatographic comparison with authentic 4-methyl-3-carboxyethylpyrrole-2,5-dicarboxylic acid (II), 4-methyl-3-ethylpyrrole-2,5-dicarboxylic acid (III) and 4-methylpyrrole-2,3,5-tricarboxylic acid (IV). With the exceptions of stercobilin and stercobilinogen all the pigments examined gave the acid (II) on oxidation; the same acid was obtained from the glaucobilin produced from stercobilin by treatment with sulphuric acid and from synthetic glaucobilin. The acids III and IV, which would be expected to arise from bile pigments derived from protoporphyrin on fission at the β-, γ- or δ-linkages, could not be detected in the products of oxidation of any of the pure bile pigments or of the mother liquors from the isolation of *d*-urobilin. The yields of the acid II indicated in Table 1, are those obtained from equivalent quantities of pigment and were assessed by inspection of the size of the chromatogram spots. The results permit the following conclusions to be drawn:

(*a*) The common bile pigments, including bilirubin, *d*-urobilin and stercobilin (after conversion to glaucobilin) are wholly IX-α in structure.

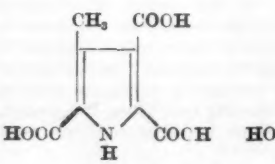
(*b*) Oxidation of stercobilin and stercobilinogen proceeds without the formation of pyrrolic acids. This is an interesting indication that the two end-rings *A* and *D* are completely hydrogenated and of a stable aliphatic nature. In agreement it was found that the monopyrrole V, which resembles the latest structure postulated for stercobilin[6] in having a saturated α-substituent, furnishes no trace of acid II under the conditions of oxidation used for the bile pigments. In contrast, the oxidation of mesobilirubinogen and *d*-urobilin (in which the groups attached to the dipyrrylmethene unit have an element of unsaturation) produced acid II. The



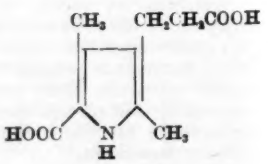
(II)



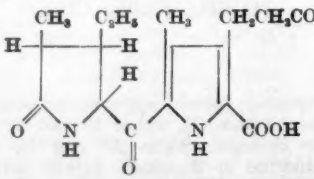
(III)



(IV)



(V)



(VI)

product arising from stercobilin appears to be a water-soluble acid which forms an optically active, 2,4-dinitrophenylhydrazone. It is possible that stercobilin undergoes fission at the *b*-12 or *b*-13 bond with formation of a product of the type VI. A study of the nature of this product is being undertaken.

One of us (R. A. N.) is indebted to the National Research Council (Rome) for financial support.

C. H. Gray
D. C. Nicholson
R. A. Nicolaus

Department of Chemical Pathology,
Medical School,
King's College Hospital,
London, S.E.5.

[1] Gray, C. H., Neuberger, A., and Sneath, P. H. A., *Biochem. J.*, **47**, 87 (1950).

[2] Nicolaus, R. A., Mangoni, L., and Caglioti, L., *Annali di Chimica*, **46**, 793 (1956). Nicolaus, R. A., and Nicoletti, R., *ibid.*, **47**, 87 (1957). Nicolaus, R. A., Mangoni, L., and Nicoletti, R., *ibid.*, **47**, 178 (1957). Nicolaus, R. A., and Caglioti, L., *Ricerca Scient.*, **27**, 113 (1957). Nicolaus, R. A. and Nicoletti, R., *ibid.*, **27**, 113, 1527 (1957). Nicolaus, R. A., and Mangoni, L., *ibid.*, **27**, 1866 (1957).

[3] Fischer, H., and Orth, H., "Die Chemie des Pyrrols" (1943).

[4] Plieninger, H., and Decker, M., *Liebigs Annalen*, **598**, 198 (1956).

[5] Lemberg, R., and Legge, J. W., "Hæmatin Compounds and the Bile Pigments", 103 (Interscience Publications, New York, 1949).

[6] Gray, C. H., and Nicholson, D. C., *Nature*, **179**, 264 (1957).

[7] Gray, C. H., and Nicholson, D. C., *Nature*, **180**, 336 (1957).

A Ribonucleoprotein from Amphibian Gastrulæ

Disaggregation of amphibian embryos by agents which chelate calcium is succeeded by re-aggregation if the cells are returned to a medium containing calcium[1]. It is customary to consider that the removal of calcium from the environment of the cells is responsible for the loss of adhesion displayed in disaggregation. An attempt has been made to find out whether any organic material is removed from the embryos during disaggregation. Such organic material might lie on the cell surfaces or between the cells and assist in their adhesion, or it might be removed from within the cells during disaggregation. Batches of 250–260 late gastrulæ of *Xenopus laevis* were disaggregated in 0·001 *M* ethylene diamine tetraacetate at *p*H 8·03 in *tris*-hydrochloric acid buffer (0·001 *M* in *tris*) made up in calcium-free Holtfreter solution. The embryos were gently agitated on a rocker for 40 min. at 19–21° C., and at the end of this period the cells of the completely disaggregated embryos were allowed to settle. No evidence of cytolysis of the cells could be found. The supernatant was removed and centrifuged at 300–400 *g* for 10 min. A small number of intact cells, and a few yolk platelets probably of extracellular origin, formed the residue. The clear supernatant from this centrifugation was examined spectrophotometrically, and the absorption curve suggested the presence of nucleic acids. The preparation was frozen-dried.

Estimations of the total nitrogen by the Lubochinsky test, phosphorus as phosphate after digestion in concentrated sulphuric acid, ribose by the orcinol reaction, and α-amino nitrogen by the ninhydrin method were made. Deoxyribose and hexose sugars were absent. After hydrolysis in perchloric acid the material was run on a chromatogram using *iso*propanol/hydrochloric acid/water (170 : 41 : to 250 vol.) as the solvent. Adenine, guanine, cytosine and uracil were recognized from the R_F values and from the absorption curves of the eluates of the spots. The extinction values of the various bases suggest that the nucleic acid forms 25 per cent of the dry weight of the material. This value is in agreement with the results of the other tests, and with the 260/280 mμ absorption ratio for the untreated material, which all give 75 per cent of protein in the preparation. A sample of the material was hydrolysed in 6 *N* hydrochloric acid, and a chromatogram of this hydrolysate was run in phenol saturated with water. Qualitatively, arginine, histidine and tyrosine have been recognized from R_F values and from specific reactions; exact identifications of the remaining amino-acids have not yet been done.

Embryos of this stage disaggregate in calcium-free media at or above *p*H 9·8, forming a clear jelly between the cells in the process, and show a certain amount of cytolysis. On returning the cells to *p*H 6·8 in the absence of calcium, the jelly slowly dissolves; if the return to *p*H 6·8 is done in the presence of calcium, the jelly remains. At this lower *p*H the jelly is dissolved by trypsin and by ribonuclease. It is possible that the jelly is at least in part identical with the ribonucleic acid and protein described above, though there is undoubtedly some degree of contamination with cytolytic products. Since ethylene diamine tetraacetate removes the ribonucleic acid and protein components from the embryos without visible damage to the cells, the suggestion is that they are derived from the surface of the cells or from between them. This is supported by histochemical evidence for the presence of ribonucleoproteins on or between the cells from methyl-green pyronin and toluidine blue staining (cf. ref. 2). The constant proportion that existed between the ribonucleic acid and protein components from batch to batch favours the view that they exist as a ribonucleoprotein in the embryo. Until the matter has been further investigated, it is probably most convenient to refer to the material as a ribonucleoprotein. It may be connected in function with the adhesion of cells to one another and with the binding of calcium on the cell surface, which is important in adhesion[3]. This function of ribonucleic acid on the cell surface has been suggested for *Elodea*[4]. It is of interest that if the disaggregated cells are treated with trypsin or ribonuclease they fail to re-aggregate, which suggests that there is a ribonucleoprotein on the cell surface connected with adhesion. It might also be concerned with induction and be related to the substance described by Niu[5].

I thank Prof. C. H. Waddington for his interest and for providing facilities for the work in the Institute of Animal Genetics, Edinburgh, Prof. J. N. Davidson for his interest and advice, and the Department of Scientific and Industrial Research for a maintenance grant.

A. S. G. Curtis*

Institute of Animal Genetics,
West Mains Road,
Edinburgh 9.
Sept. 27.

* Present address: Department of Anatomy, University College, Gower Street, London, W.C.1.

[1] King, T. J., and Briggs, R., *Proc. U.S. Nat. Acad. Sci.*, **41**, 321 (1955).

[2] Brachet, S., "Embryologie chimique" (Desoer, Liège, 1944).

[3] Curtis, A. S. G., *Proc. Roy. Phys. Soc. Edin.* (in the press).

[4] Lansing, A. I., and Rosenthal, T. B., *J. Cell. Comp. Physiol.*, **40**, 337 (1952).

[5] Niu, M. C., in "Cellular Mechanisms in Differentiation and Growth", edit. by Rudnick, D., 155 (Princeton, 1956).

β-Glucuronidase, Lipase and Esterase in the Testis of the Cryptorchid Rat

Although considerable attention has been paid to lipase and esterase in the testis[1], comparatively little is known of β-glucuronidase in this organ. This communication is concerned with some relationships between testicular β-glucuronidase, lipase and esterase of the rat in artificial cryptorchidism.

Thirty-four albino rats of the Wistar stock bred in this laboratory were used and grouped as follows: normal control (13), unilateral cryptorchidism (9), bilateral cryptorchidism (12). Determinations of enzyme activity in tissue homogenates were made according to the method of Talalay *et al.*[2] for β-glucuronidase, of Nachlas *et al.*[3] for lipase and for esterase; the units used were the amount of enzyme which liberates 1 μgm. of phenolic substance in 1 hr. for β-glucuronidase and for lipase, and in 20 min. for esterase[4].

Table 1

	Normal control	Cryptorchidism		
		Unilateral		Bilateral cryptorchid testes
		Normally located testis	Cryptorchid testis	
No. of rats	13	9		12
Body-weight (gm.)	132±10*	136±6·8		160±8·9
Testicular weight (mgm.)	742±80	1,078±100	567±69	541±58
β-Glucuronidase activity†	146±14	222±44	722±242	1,333±136
Lipase activity†	12±1·6	29±4·2	52±3·8	34±4·2
Esterase activity†	7,341±126	7,284±447	9,179±502	9,178±639

* Mean ± standard error of the mean.
† Units per gm. of wet tissue.

In the testis of the cryptorchid rat four weeks after operation, the concentrations of all three enzymes showed an increase. The most striking change was seen in the β-glucuronidase level. The concentration of this enzyme in the testis increased nine-fold in the bilaterally cryptorchid rat and five-fold in the unilaterally operated animal. Lipase concentration, however, increased much more in the cryptorchid testis of the unilaterally cryptorchid animal than in the bilaterally operated animal. The increase in the concentration of esterase was slight and the same in both groups. It should also be noted that β-glucuronidase and lipase activities were significantly ($P<0·05$) elevated in the normally located testis of the unilaterally cryptorchid animal. Results are shown in Table 1.

A full account of this work will appear elsewhere.

Masando Hayashi
Kazuhiro Ogata
Takuro Shiraogawa
Osamu Kawase

Department of Pathology,
Research Institute for
Diathetic Medicine,
Kumamoto University,
Kumamoto, Japan.

[1] Verne, J., and Hébert, S., *Ann. Endocrinol.*, **13**, 659, 924 (1952). Verne, J., *ibid.*, **14**, 747 (1953). Huggins, C., and Moulton, S. H., *J. Exp. Med.*, **88**, 169 (1948). Morii, S., *Acta Schol. Med. Univ. Kioto*, **34**, 1 (1956).

[2] Talalay, P., Fishman, W. H., and Huggins, C., *J. Biol. Chem.*, **116**, 757 (1946).

[3] Nachlas, M. M., and Seligman A. M., *J. Biol. Chem.*, **181**, 343 (1949); *J. Nat. Cancer Inst.*, **9**, 415 (1949).

[4] Ogata, K., Simoda, K., Takamori, T., Shiraogawa, T., Yokota, H., Hayashi, M., and Kawase, O., *Kumamoto Med. J.*, **8**, 168 (1955).

Inhibition of 5-Hydroxytryptophan Decarboxylase by Phenylalanine Metabolites

Evidence has recently been presented which demonstrated a lowered level of circulating 5-hydroxytryptamine in patients with phenylketonuria[1]. The condition is associated with production of an excess of certain aromatic acid metabolites of phenylalanine, which it has been claimed inhibit dihydroxyphenylalanine decarboxylase[2]. It was suggested that this inhibitory effect was an explanation of the low plasma levels of adrenaline found in phenylketonuria. As 5-hydroxytryptamine is derived from 5-hydroxytryptophan by the action of 5-hydroxytryptophan decarboxylase[3] it was decided to examine the effects of these aromatic acids on this enzyme system also.

Table 1. Inhibition of 5-Hydroxytryptophan Decarboxylase by Phenylalanine Metabolites

Additions	Conc. (μmoles/3 ml.)	μl.CO_2/40 min.	Inhibition (per cent)	Inhibition of dihydroxyphenylalanine decarboxylase* (per cent)
Control	—	75·7	—	—
Phenylpyruvic acid	100	15·7	79·3	100
	50	38·3	49·5	100
	10	74·2	2	77
Phenyl-lactic acid	100	36	52·5	100
	50	66	13	77
	10	71·2	6	50
Phenylacetic acid	100	12·5	83·5	50
	50	24·2	68	0
	10	—	—	0
L-Phenyl-alanine	100	65·7	13	0

Guinea pig kidneys were homogenized in ice-cold *M*/30 Sørensen's phosphate buffer *p*H 6·8. The homogenate was centrifuged in the cold for 5 min. and 2 ml. of the supernatant (equivalent to 2 gm. of original wet tissue) used in each Warburg flask. 25 μgm. of pyridoxal phosphate and the inhibitor, dissolved in phosphate buffer, was added. The volume was adjusted to 2·75 ml. with phosphate buffer. After gassing for 2 min. with nitrogen, the flasks were equilibrated at 37° for 10 min. and 0·25 ml. of DL-5-hydroxytryptophan (10 μmoles) added from the side-arm. Controls and blanks were also used. Carbon dioxide output was determined for 40 min.

* After Fellman (ref. 2). Dihydroxyphenylalanine (20 μmoles) as substrate.

Phenylacetic acid was found to be more active and phenylpyruvic and phenyl-lactic acids were less active as inhibitors of 5-hydroxytryptophan decarboxylase when compared with the results presented by Fellman[2] for dihydroxyphenylalanine decarboxylase, which is similar to but not identical with 5-hydroxytryptophan decarboxylase[3].

These results, although preliminary, suggest the possibility that such an inhibition, *in vivo*, might be responsible for the decreased production of 5-hydroxytryptamine observed in patients with phenylketonuria. As there is a large body of evidence to suggest that 5-hydroxytryptamine plays a part in normal brain function, inhibition of 5-hydroxytryptophan decarboxylase, present in some areas of the brain in high concentration[4], might thus contribute to the cause of the mental defect in this disease.

It is of interest to note that ingestion of phenylacetic acid in man is followed by transitory mental disturbance[5]. But before the inference can be drawn that this effect is due to inhibition of 5-hydroxytryptophan decarboxylase more work must be done on the mechanism of this inhibition, and the possible inhibitory action on other enzyme systems[6] must be studied.

We are grateful to Dr. L. I. Woolf for gifts of the aromatic acids used.

A. N. Davison

Dept. of Pathology,
Guy's Hospital Medical School,
London, S.E.1.

M. Sandler

Dept. of Chemical Pathology,
Royal Free Hospital,
London, W.C.1.

[1] Pare, C. M. B., Sandler, M., and Stacey, R. S., *Lancet*, **i**, 551 (1957).
[2] Fellman, J. H., *Proc. Soc. Exp. Biol., N.Y.*, **93**, 413 (1956).
[3] Clark, C. T., Weissbach, H., and Udenfriend, S., *J. Biol. Chem.*, **210**, 139 (1954).
[4] Gaddum, J. H., and Giarman, N. J., *Brit. J. Pharmacol.*, **11**, 88 (1956).
[5] Sherwin, C. P., Wolf, M., and Wolf, W., *J. Biol. Chem.*, **37**, 113 (1919).
[6] Bickis, I. J., Kennedy, J. P., and Quastel, J. H., *Nature*, **179**, 1124 (1957).

Role of Ferrous Iron in Enzymatic Transamination

Although the part played by metals in non-enzymatic transaminations is known, its role in the enzymatic reaction of this type is still to be proved. Aluminium, nickel, copper and iron are known to catalyse the non-enzymatic reaction between an amino-acid and pyridoxal, or a keto-acid and pyridoxamine. Recently, Fasella *et al.*[1] have isolated the intermediates involved. This preliminary communication reports the possibility of iron (in its reduced state) being involved in the enzymatic transamination.

The source of the enzyme was the fresh green beans of *Dolichos lablab*. From the residue after acetone extraction of the beans, aspartic–glutamic transaminase was purified by 'Dowex-2' (in chloride form), calcium phosphate gel and alumina $C\gamma$ treatment. Electrophoresis (on paper) showed that the enzyme moved as a single component (pH 9·0, glycine–sodium hydroxide buffer, 4 cm. in 4 hr., 440 V., 26° C.) indicating a high state of purity. This purified preparation was used in the present work.

Preliminary experiments showed that metals such as aluminium, nickel, copper, magnesium, manganese and cobalt had no appreciable effect on the activity of the enzyme. Ferrous sulphate produced an increase in its activity, whereas mercury (as mercurous chloride) completely inhibited it.

As shown in Table 1, dialysis against 8-oxyquinoline solution (0·005 M) for 17 hr. in the cold reduced the activity of the enzyme considerably, but it was completely restored by addition of about 5 μgm. of ferrous iron (as $FeSO_4.7\,H_2O$) to the reaction mixture. Also there was no non-enzymatic transamination either in the presence or the absence of ferrous iron. Ferric iron (as $Fe_2(SO_4)_3$) was not active. Addition of ferrous iron to the undialysed enzyme had no effect. Among the various iron binders studied it was noticed that addition of glutathione, versene (disodium salt), O-phenanthroline and α-α-dipyridyl inhibited the activity by 10–20 per cent. Cyanide completely destroyed the activity, whereas 8-oxyquinoline had no effect at all.

Table 1. Effect of Ferrous Iron on Aspartic–Glutamic Transaminase

Reaction carried out at 37° C. for half an hour under nitrogen. Activity estimated by the method of Tonhazy (ref. 3)

Additions	Pyruvate formed (μgm.) per mgm. protein
Enzyme (undialysed) + asp. + KG	1,120
Enzyme (undialysed) + asp. + KG + 5 μgm. Fe^{2+}	1,160
Enzyme (dialysed) + asp. + KG	400
Enzyme (dialysed) + asp. + KG + 5 μgm. Fe^{2+}	1,230
Enzyme (boiled) + asp. + KG	Nil
Enzyme (boiled) + asp. + KG + 5 μgm. Fe^{2+}	Nil
Asp. + KG	Nil
Asp. + KG + 5 μgm. Fe^{2+}	Nil

asp. = DL-aspartic acid. KG = α-ketoglutaric acid.

Thus there appears to be an indication, for the first time, that a metal is involved in enzymatic transamination. In this connexion it can be stated that Dr. Cohen reported the presence of a strong Fe band in one of the Merck preparations of pyridoxal phosphate which was found to be twice as active as pyridoxal phosphate from other sources[2]. No exogenous coenzyme was used in the present investigation. Further work is in progress to isolate the enzyme in a high state of purity, in order to find whether there is iron in the enzyme, and also its mode of action.

I wish to thank Dr. M. Srinivasan and Mr. Nagabhushanam for their helpful discussions, and Dr. V. Subrahmanyan, director of this Institute, for his interest in the present investigation. Thanks are also due to Glyco Products Inc., New York, for a gift of versene.

M. V. Patwardhan

Division of Biochemistry and Nutrition,
Central Food Technological Research Institute,
Mysore, India.

[1] Fasella, P., Lis, H., Siliprandi, N., and Baglioni, C., *Biochim. Biophys. Acta*, **23**, 417 (1957).
[2] "Amino-acid Metabolism", Symposium, McCollum-Pratt Institute, p. 56 (1955).
[3] Tonhazy, N. E., White, N. G., and Umbreit, W. W., *Arch. Biochem.*, **28**, 36 (1950).

Effect of Testosterone and Orchidectomy on the Activity of the Melanocytes in the Skin

It is well known that there is an increased pigmentation of the skin in certain areas of the body in pregnancy. It has also been established that the occurrence of a malignant change in benign pigmented tumours or moles is rare before puberty in both sexes. Furthermore it is accepted that the growth of malignant melanomas and the formation of metastases is accelerated during pregnancy[1]. All these facts suggest that the activity of the melanocyte is under hormonal influence. Edwards, Hamilton, Duntley and Hubert[2] reported that the human male castrate has a reduced amount of melanin in the skin. Treatment of these men with testosterone usually increased the melanin content in all areas, although the response was of small degree. Kupperman[3], working on the male golden hamster, showed that testosterone increases the pigmentation of the skin, whereas castration causes a reduction in pigmentation. Wheeler *et al.*[4] found by macroscopical and microscopical observations that topical application of testosterone to the nipples and areolæ of immature castrated male guinea pigs produced no increased pigmentation. The present investigation was designed to

investigate histochemically the effect of testosterone and orchidectomy on the activity of the melanocyte.

Eighteen male guinea pigs weighing about 400 gm. were used. The animals were divided into three groups, each consisting of three pure black and three red guinea pigs. Skin biopsies were taken from all the animals from the right ear, right side of the anterior abdominal wall in the hypochondriac region and from the sole of the right foot. In addition, the right areola, including the nipple, was excised. The first group of animals was orchidectomized, received no hormone treatment, and was left for four weeks. The second group of animals was also orchidectomized, and four weeks later a course of testosterone was commenced. The animals were given 2 mgm. of testosterone propionate (Organon) intramuscularly once daily for 5 days a week for a period of 4 weeks. The third group of animals was left intact and was given a 4-week course of testosterone injections identical with that received by the animals of the second group. The animals were killed by a blow on the back of the neck, and a further series of skin specimens was removed from areas adjacent to those taken previously, and the left areola, including the nipple, was excised.

Most of the sheets of skin were left intact after excess subcutaneous fat and the deeper part of the dermis had been excised under a dissecting microscope. A few of the specimens, however, were treated with trypsin to disengage the epidermis. The skin was then incubated with the dopa reagent after preliminary fixation. The greater part of each skin sheet was then mounted; the remainder was embedded in paraffin and sagittal sections were cut. The hormonal influence on the melanocytes was studied by assessing the number and size of the melanocytes and the amount and position of the melanin within the cells in the skin specimens removed before and after treatment. The number, length and complexity of the dendritic processes were also noted, and an attempt was made to assess the amount of free melanin present in the vicinity of the cells.

The results were as follows:

Skin of ear. Following orchidectomy, no definite changes were noted. In the orchidectomized animals which received testosterone, in 2 of the animals the size of the melanocytes became reduced. In 3 of the animals, which included the 2 with a reduction in cell size, the dendrites were increased in length. The amount of melanin in the basal layer of the epidermis was increased in all the animals, but it was impossible to determine whether this increase had occurred within the melanocytes or in the surrounding tissue. In the intact animals which received testosterone the number of melanocytes became reduced in three of the animals and it was seen that the length and complexity of the dendrites of these cells were reduced. Furthermore it was noted that the amount of free melanin in these animals was increased.

Skin of anterior abdominal wall. Orchidectomy increased the number of melanocytes in 5 of the animals. In 2 of these the size of the melanocytes become reduced and in one it was increased. It was also seen that in 3 of the animals the amount of free melanin had increased, but this could not be correlated with the melanocyte changes. In the orchidectomized animals which received testosterone no uniform change occurred. There was a slight tendency for the size of the melanocytes and the amount of intracellular melanin, and the length and complexity of the dendrites, to become reduced. In the intact animals which received testosterone, no definite changes were seen.

Skin of areola. In the orchidectomized animals the changes noted were inconsistent. In 2 of the animals, however, the number of melanocytes and the amount of free melanin increased. In another 2 animals the length and complexity of the dendrites increased. In the orchidectomized animals which received testosterone no uniform changes occurred. In the intact animals which received testosterone, in 3 of the animals the number of melanocytes became increased. In 4 animals the amount of free melanin was increased, but in one animal it was reduced.

Sole of foot. In all three groups of animals the amount of melanin in the basal layer of the epidermis showed a definite increase.

The above findings show that orchidectomy, orchidectomy followed by testosterone, or testosterone alone, are incapable of producing uniform changes in the melanocytes and in the intra- and extra-cellular melanin in the skin of the ear, anterior abdominal wall and areola. It is therefore concluded that the melanocytes in the skin of these regions are not directly influenced by the male sex hormone. The results in the skin of the sole of the foot are, however, constant, and indicate that any change in the amount of male sex hormone will produce an increase in melanogenic activity. This is of particular interest in view of the high incidence of malignant change in pigmented lesions of the sole of the foot in man.

We gratefully acknowledge financial assistance from the Medical Research Council for this work.

P. G. Bischitz
R. S. Snell

Department of Anatomy,
King's College,
London, W.C.2.
Sept. 30.

[1] Cade, S., *Brit. Med. J.*, II, 119 (1957).
[2] Edwards, E. A., Hamilton, J. B., Duntley, S. Q., and Hubert, G., *Endocrinol.*, **28**, 119 (1941).
[3] Kupperman, H. S., *Anat. Rec.*, 88, 442 (1944).
[4] Wheeler, C. E., Cawley, E. P., and Curtis, A. C., *J. Invest. Dermat.*, **20**, 385 (1953).

Effect of some Nitrogen Mustard Derivatives on Growth of Rabbit's Hair

The stimulating effect of ionizing radiations on the growth of rabbit's hair has been noted recently[1]. It may be of interest to record that similar effects have been found following the application of certain nitrogen mustard derivatives to rabbit skin.

In 1948, the preparation of mustard derivatives of desylamine, $C_6H_5COCH(NH_2)C_6H_5$, was undertaken for studies in cancer chemotherapy. Desyl chloride, $C_6H_5COCHClC_6H_5$, and the *p*-methoxy bromo compound, $CH_3OC_6H_4COCHBrC_6H_5$, were prepared by standard methods and allowed to react with diethanolamine. The resulting bases,

$$RC_6H_4COCH\{N[(CH_2)_2OH]_2\}C_6H_5$$

had the following properties: for R = H, m.p. = 136 – 137° C., N per cent found = 4·46, N per cent calc. = 4·68; for $R = CH_3O$, m.p. = 108 – 109° C., N per cent found = 4·40, N per cent calc. = 4·26. Cold chloroform solutions of these products were treated with thionyl chloride (in the case of the methoxy derivative, the reaction mixture exhibited a transient deep blue-green colour) and, after removal of chloroform, white substances were obtained.

These compounds, which were hygroscopic and seemed to be susceptible to decomposition, were stored *in vacuo*. Analyses were unsatisfactory, but indicated that the products probably consisted mainly of hydrochlorides of the mustard derivatives,

$$RC_6H_4COCH\{N[(CH_2)_2Cl]_2\}C_6H_5$$

No further chemical studies were made with the substances; but their ability to produce blisters on the shaved skin of rabbits was investigated.

On November 17, 1948, a drop of a chloroform solution of the desyl mustard derivative ($R = H$; ~20 mgm.) was placed in the middle of a shaved area on the belly of a Dutch rabbit. The skin reddened at the site of application, and, 3 days later, a yellow area of thickened skin (blister) had formed at this site. On November 23, a thick keratinous layer was observed along the line of application of the mustard solution and by November 29 the keratin had sloughed off leaving a mark resembling a knife incision. On December 9, it was observed that hair about 1 cm. in length had grown on this mark, but the surrounding shaved area remained free from hair. On December 16, hair on the 'wound' site had grown to normal length and by February 21, 1949, a thick tuft of hair was growing on the site of application of the mustard while the rest of the shaved area remained hairless. On this day, fur was shaved from a fresh area of the experimental animal and a control animal was shaved on the belly. By March 3, 1949, there was a light growth of hair on the shaved area of the control animal and the site was completely covered with hair on March 10. At this time the recently shaved area on the mustard-treated rabbit showed no growth of hair.

Other rabbits were shaved on both flanks and one flank of each was treated with desyl or methoxy-desyl mustard on December 11, 1948. On February 28, 1949, growth of hair was observed on the painted site but scarcely any on the surrounding shaved area or on the control shaved flank.

Experiments with di-2-chloroethyl sulphide and di-2-chloroethylamine led to early death of the treated rabbits, so it remains uncertain whether these substances have the same action as the desyl mustards. It should be of interest to determine whether the observed effects can be obtained with other radiomimetic agents or carcinogenic substances.

The work described here was carried out with the aid of a grant from the British Empire Cancer Campaign. I am at present in receipt of a James Morrison Research Fellowship.

WILLIAM J. P. NEISH

Cancer Research Unit,
University of Sheffield.

[1] Jolles, B., and Greening, S. G., *Nature*, **179**, 1082 (1957).

Effects of Gibberellic Acid on Soil Micro-organisms

GIBBERELLIC acid, a metabolic product of the fungus, *Gibberella fujikuroi*, has shown marked effects on plant growth, stimulating stem and leaf elongation. British investigators[1] have studied its influence on a number of bacteria and moulds and have briefly stated they were unable to detect any effect, either inhibitory or stimulatory. Although there is indirect evidence that gibberellic acid is rapidly decomposed in the soil[1], there have been no reports concerning action of the acid on soil micro-organisms and their activities. The following preliminary experiments were carried out to determine if gibberellic acid had any effect on terminal respiration of the soil microbial population in conventional Warburg runs.

5-gm. portions of air-dry sandy loam soil passing a 10-mesh sieve were placed in Warburg vessels[2]. The soil had a water-holding capacity of 37 per cent; 0·80 per cent total carbon and 0·06 per cent total nitrogen were present. Gibberellic acid, dissolved in a drop of ethanol, was added to duplicate flasks of the soil to give concentrations of 0, 1, 3, 5, 50 and 100 p.p.m. Glucose treatments at 2,000 p.p.m. carbon and ethanol controls in duplicate were included. In addition to the soil (vol., 2·5 ml.), each flask contained 0·5 ml. substrate and 0·2 ml. 20 per cent potassium hydroxide. Runs were made for 15 hr. at 29·8° C. and all values were corrected. The $Q_{O_2}N$ values were considerably increased by the ethanol. No significant increases were given by gibberellic acid; in some instances it gave slight decreases.

At the close of the respiration experiment, soil from the Warburg flasks was removed, appropriately diluted, and plated in quadruplicate for microbial counts and incubated at 28° C. Sodium albuminate agar was used as the medium for bacteria and *Streptomyces*, and peptone–glucose agar acidified to *p*H 3·9 was used for soil fungi. Plates were counted as soon as colonies could be well differentiated. Results were analysed statistically. The F values for treatments and interactions were significant at the 1 per cent level. The results disclosed that gibberellic acid in comparison with ethanol controls apparently induced some stimulations and some inhibitions not consistent with the rates of application. An explanation of these variations cannot be given from present information.

The most significant observation was that with the ethanolic gibberellic acid treatment at 50 p.p.m. + glucose, and ethanolic gibberellic acid at 100 p.p.m. + glucose, numerous colonies of *Azotobacter chroococcum* (as determined by cultural and microscopic examination), a non-symbiotic nitrogen-fixing bacterium, occurred on all replicate sodium albuminate agar plates. No such colonies were found on dilution plates from any of the soil treatments which did not include gibberellic acid. It is evident, however, that *Azotobacter*, in lesser numbers, must have been present in the original soil. This was confirmed by observation of typical *Azotobacter* colonies that developed on plaques of soil–starch paste. Therefore, in another experiment, which confirmed the first Warburg results, soil from the flasks was air-dried, sieved and tested for *Azotobacter*, using the nitrogen-free agar plate method[3]. After five days, *Azotobacter* were found to be numerous in all samples, but appeared most abundant with ethanolic gibberellic acid at 50 p.p.m. + glucose (Table 1).

Table 1. *Azotobacter* COLONIES FROM SOILS AFTER 15-HR. RESPIRATION IN WARBURG FLASKS

Treatment	Colonies per gm. soil*
Soil + gibberellic acid, 1 p.p.m.	2,200
Soil + gibberellic acid, 3 p.p.m.	3,200
Soil + gibberellic acid, 5 p.p.m.	2,600
Soil + gibberellic acid, 25 p.p.m. + glucose at 2,000 p.p.m. C.	2,400
Soil + gibberellic acid, 50 p.p.m. + glucose at 2,000 p.p.m. C.	3,400
Soil + glucose at 2,000 p.p.m. C.	2,000
Soil + ethanol, 14 p.p.m.	2,400
Soil only	2,000

* Average of duplicates

Further studies are in progress to determine if 'Gibrel', a water-soluble potassium salt of gibberellic acid, has a significant effect on nitrogen fixation by *Azotobacter*.

The gibberellic acid was kindly supplied by Dr. L. T. Blaney of the Horticulture Department. It was originally obtained from Dr. P. W. Brian of Imperial Chemical Industries, Ltd., England. The 'Gibrel' was supplied by Merck and Co., Inc., New Jersey.

K. C. Lu
C. M. Gilmour
A. C. Zagallo
W. B. Bollen

Department of Bacteriology,
Oregon Agricultural Experiment Station,
Corvallis, Oregon.
Oct. 21.

[1] Brian, P. W., Hemming, G. W., and Radley, M., *J. Sci. Food and Agric.*, **5**, 602 (1954).
[2] Gilmour, C. M., Bollen, W. B., and Damsky, L., Agronomy Absts., 20 (1955).
[3] Martin, W. P., Ariz. Agric. Exp. Sta. Tech. Bull. 83 (1940).

Enzymes in the Ileal Juice of the Horse

So far as can be ascertained there is no information about the enzymes secreted by the horse's small intestine. Since a pony with a Thiry–Vella loop in the middle of the ileum was available[1] the opportunity was taken to determine whether the enzymes present in man and dogs were present in the horse. The juice was obtained by gently rubbing the mucosa with a rubber catheter. Juice thus obtained was, on occasion, slightly contaminated with blood. However, the enzymic activity of such samples did not differ from the uncontaminated.

Ileal juice is a watery fluid with a yellow tinge and sometimes contained mucus. The *p*H was 7·8–8·5. Enzymic activity was measured on the supernatant fluid from juice centrifuged at 3,000 r.p.m. for 5 min.

Amylase, lactase, maltase, and sucrase activity was detected by Lagerlof's[2] method, lipase activity by Cherry and Crandall's[3] method, peptidase by Cajori's[4] technique using a peptone substrate and protease by Lagerlof's[5] method with casein as substrate. Enterokinase activity was detected by using the protease method after adding 2 ml. of 0·01 per cent trypsinogen (Worthington Biochemical Corporation) to 6 ml. incubating mixture and using controls without trypsinogen and also with boiled juice. This method showed marked enterokinase activity in the ileal juice of freshly killed rats and guinea pigs. The experimental findings are shown in Table 1; the dilution of juice was the highest at which activity could be detected by the methods used.

Table 1. Enzymes in Horse Ileal Juice

Enzyme	No. of observations	Activity present	Dilution of juice
Amylase	18	14	1 : 1,000
Sucrase	14	12	1 : 20
Lactase	19	17	1 : 1,000
Maltase	19	16	1 : 1,000
Lipase	4	0	Undiluted
Lipase	6	0	1 : 5
Protease	16	15	1 : 10
Peptidase	14	14	1 : 10
Enterokinase	7	1	Undiluted

It was interesting to compare the results of these experiments with those of Doller and Porter[6], who studied the enzymes of the calf's digestive tract. They found no sucrase activity in the calf's ileum and that the lactase activity decreased with age.

The absence from the horse juice of lipase activity was noteworthy, although Reale[7] has stated that lipase was absent from fresh ileal juice in man but increased with cellular autolysis, and Roger and Binet[8] suggested that bile increased lipolytic activity by destroying cells. However, in our experiments both centrifuged juice, macerated mucus and cellular debris were free from lipolytic activity. In control experiments the method employed showed marked lipolytic activity in ileal juice of rats and guinea pigs.

The absence of enterokinase activity could be explained by the Thiry–Vella loop being six years old, as Foa[9] showed the enzyme to disappear from fistulæ of dogs within six months of operation, and Sawitsch[10] found the enzyme to disappear from fistulæ deprived of pancreatic juice.

F. Alexander
A. K. Chowdhury*

Department of Veterinary Pharmacology,
University of Edinburgh,
Royal (Dick) School of Veterinary Studies,
Edinburgh, 9.

* Colombo Plan Scholar.

[1] Alexander, F., *J. Physiol.*, **115**, 63*P* (1951).
[2] Lagerlof, H. O., *Acta Med. Scand.*, Supp., **128**, 18 (1942).
[3] Cherry, I. S., and Crandall, L. A., *Amer. J. Physiol.*, **100**, 266 (1932).
[4] Cajori, F. A., *Amer. J. Physiol.*, **104**, 659 (1933).
[5] Lagerlof, H. O., *Acta Med. Scand.*, Supp., **128**, 38 (1942).
[6] Doller, A. M., and Porter, J. W. G., *Nature*, **179**, 4573 (1957).
[7] Reale, L., *Boll. Soc. Ital. Biol.*, **7**, 1380; **8**, 492 (1932).
[8] Roger, H., and Binet, L., *C.R. Soc. Biol., Paris*, **85**, 648 (1921).
[9] Foa, C., *Arch. Physiol.*, **5**, 26 (1908).
[10] Sawitsch, W. W., Diss. St. Petersburg (1904).

Effect of Electrolytes on the Uptake by Bacteria of Labelled Glutamate

In a recent paper, Krebs, Whittam and Hems[1] reported an accelerating effect of potassium salts on the rate of oxidation of various substrates by *Alcaligenes faecalis*. All the potassium salts tested were equally active. The ionic composition of the medium was found to affect respiration also in *Escherichia coli* (strain *B*), and *Pasteurella tularensis* (strain $S + D$)[2]. The effect of the anion was also apparent with these two micro-organisms. For the maximal rate of oxidation of glutamate and glucose by *P. tularensis* the halogen salts of potassium and rubidium were found to be required; in the case of *E. coli* potassium chloride or sulphate was needed. In *E. coli* addition of minute amounts (10^{-4} *M*) of sodium salts rendered the accelerating effect of potassium independent of the nature of the anion. Conditions known to diminish the rate of penetration of metabolites into the bacterial cell (rising *p*H, low substrate concentration) rendered the accelerating effect of potassium more pronounced. The latter observation suggested regulation of permeability as a possible mode of action of the electrolytes. In order to test the validity of this assumption, the effect of electrolytes on the rate of uptake of labelled glutamate was examined.

The composition of the reaction mixture was as follows: 15 mgm./ml. (wet weight) of the bacterial cells, washed thoroughly with 0·25 *M* sucrose, 10^{-2} *M* of the electrolytes and 0·25 *M* sucrose.

Table 1. Effect of Cations on the Rate of Penetration of Glutamate into the Cells of *E. coli* and *P. tularensis*

Time	Counts/10 min.*									
	No electrolyte added		KCl		NaCl		LiCl		RbCl	
	E.	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*
30 sec.	40	36	240	210	50	80	50	80	70	150
3 min.	60	60	530	566	50	170	50	170	110	310
6 min.	70	80	500	560	140	260	130	260	160	410

* After the deduction of the background count (200/10 min.). 100 counts/10 min. represent approximately 3×10^{-6} μmole of glutamate.

After thermal equilibration (28° C.) 0·03 *M tris* glutamate and glutamate uniformly labelled with carbon-14 (0·01 μc./ml.) were added, samples of 3·0 ml. were withdrawn at various time-intervals, chilled to 0° C. and centrifuged (30,000*g*). The radioactivity of the well-drained but unwashed cell mass was determined by a method essentially identical with the procedure adopted by Krebs *et al.*[1].

Results which show the effect of various monovalent cations (tested as their chlorides) on the rate of increase of the radioactivity in the bacterial cell mass (*E. coli*; *P. tularensis*) are given in Table 1. The modifying influence of the anions on this process is shown in Table 2. It can be seen that potassium chloride in *E. coli* and potassium chloride and rubidium chloride in *P. tularensis* which accelerate the oxidation of glutamate also increased the rate of its accumulation. Cations which were found ineffective on the respiration also had no effect on the accumulation. A mixture of potassium and sodium nitrates was as effective as potassium chloride, while each compound separately accelerated neither accumulation nor the oxidation of the substrate. The nature of the anion affected respiration and accumulation in a parallel manner.

Table 2. Effect of Anions on the Rate of Penetration of Glutamate into the Cells of *E. coli* and *P. tularensis*

Time	Counts/10 min.*											
	No electrolyte added		KCl		KBr		KNO_3		K_2SO_4		KNO_3 + $NaNO_3$	
	E.	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*
30 sec.	40	70	190	200	110	250	80	68	190	60	180	—
3 min	70	100	480	540	120	542	150	260	410	270	410	—
6 min.	90	90	560	560	130	613	180	260	440	270	595	—

* After the deduction of the background count (200/10 min.). 100 counts/10 min. represent approximately 3×10^{-3} μmole of glutamate.

In view of similarity of effect of the ionic environment on the respiration and on the 'uptake' of the substrate, consideration has to be given to the possibility that the electrolytes regulate the rate of respiration by controlling a process directly connected with the penetration of the substrate.

It remains, however, to be shown that increase in radioactivity in the cell mass is due to the penetration of the substrate into the bacteria, and furthermore, that penetration is the rate-limiting factor in the reaction sequence.

Y. Avi-Dor
Sh. Miller

Israeli Institute for Biological Research,
Ness-Ziona, Israel.

[1] Krebs, H. A., Whittam, R., and Hems, R., *Biochem. J.*, **68**, 53 (1957).
[2] Miller, Sh., and Avi-Dor, Y., *J. Gen. Microbiol.* (in the press).

Novel Action of Potassium on a Yeast and a Counteraction by Aluminium

A paper[1] from this laboratory described an improved method for the estimation of *Oospora lactis* Fres. (formerly known as *Oidium lactis*) in pressed bakers' yeast, using a medium consisting of ammonium succinate, mineral salts and agar. The method worked well with most yeasts, but one strain (*Saccharomyces cerevisiae* D.C.L. 557) prevented the growth of visible colonies of *Oospora* on the above medium. This effect has been further studied, and it has been found that the immediate cause of the inhibition was the presence in the medium of 2×10^{-2} *M* potassium (as the dihydrogen phosphate). This was demonstrated by excluding potassium from the medium, adding the phosphate as the sodium or ammonium salt. The mould then developed into dense colonies; these were not, however, quite so large as those grown on normal medium (containing potassium) in the absence of yeast. This reduction in size was due to the fact that *Oospora* required 3×10^{-4} *M* potassium ions for optimal growth on ammonium succinate, mineral salts, agar medium. When Yeast 557 was present, however, this concentration of potassium, added as sulphate or chloride to the medium (containing sodium or ammonium dihydrogen phosphate), inhibited the growth of the mould. The inhibition was largely overcome by the addition of 5×10^{-4} *M* aluminium (as ammonium alum) to the normal medium.

A similar effect was obtained with other salts of aluminium, but not with salts of other multivalent elements, calcium, magnesium, manganese or silicon. The concentration of aluminium required to counteract the inhibition indicated that the action was not a trace-element effect. In fact there was sufficient aluminium to envelop each yeast cell 10^5 times. The mechanism of the action of potassium and the counteraction by aluminium has not been elucidated.

The suggestion[2] that potassium might regulate cell permeability offered no obvious clue to the problem. Rossi[3] showed that potassium ions stimulated the oxidation of succinic acid in resting cells of *Escherichia coli* in the Warburg apparatus. It seemed possible that some oxidation product of succinic acid might be formed in this way by Yeast 557 and be inhibitory to the growth of *Oospora*. The addition to the medium of 4×10^{-3} *M* fumaric acid or of 4×10^{-2} *M* maleic acid produced no inhibition of the mould.

E. J. Miller

Research and Development Department,
The Distillers Co., Ltd.,
Epsom, Surrey.

[1] Levi, J. D., *J. Inst. Brew.*, **62**, 261 (1956).
[2] Fleming, W. R., *J. Cell. and Comp. Physiol.*, **49**, 129 (1957).
[3] Rossi, F., *Sperimentale*, **106**, 214 (1956).

Detection of Uric Acid in the Tissue Homogenates of Earthworms

Lesser[1], working on *Lumbricus agricola* and *Allolobophora foetida*, Ackermann and Kutscher[2] on extracts of tissues of earthworms, Delaunay[3] on excreta of earthworms, Heidermanns[4] on tissues of *Lumbricus*, Bahl[5] on excreta of *Pheretima*, Abdel Fattah[6] on tissue homogenate of *Lumbricus*, were all unable to detect the presence of even traces of uric acid in these worms. Only Cohen and Lewis[7] found that the non-protein nitrogen excreted by *Lumbricus*

terrestris was mainly in the form of ammonia together with small traces of both urea and uric acid.

Uric acid is known to be very sparingly soluble in water, and it is possible that the previous authors, working with water extracts of tissues, have overlooked the presence of uric acid.

As uric acid is readily soluble in lithium hydroxide, the following technique was used in the present study on *Allolobophora caliginosa* f. *tropezoides*. The worms were homogenized with water in a Potter–Elvehjem[8] homogenizer, and the homogenate was made up to a known volume. Homogenate portions were digested in a Kjeldahl apparatus for estimating its total nitrogen content, to relate the concentration of the homogenate constituents to the total nitrogen of the tissues. This was carried out since the fresh weight of the worms is not constant, owing to the different rates of desiccation of the worms. Another homogenate portion was centrifuged and the supernatant was tested for uric acid using Brown's[9] method. The residue was afterwards dissolved in 1 per cent lithium hydroxide and recentrifuged, and the centrifugate was examined again for uric acid. Both uric acid values, the water-soluble and the lithium hydroxide-soluble, were added together and related to the nitrogen content of the tissues of the worms.

It was found that the uric acid content of the tissues of the worms examined was 3·34 mgm. per gm.[3] tissue nitrogen. Further details will appear elsewhere.

Gaber M. Haggag
A. Khalaf El-Duweini

Department of Zoology,
Faculty of Science,
Cairo University.
Oct. 18.

[1] Lesser, E. J., *Z. Biol.*, **50**, 421 (1907–8).
[2] Ackermann, D., and Kutscher, F., *Z. Biol.*, **75**, 315 (1922).
[3] Delaunay, H., "Reserches biochimique sur l'excrétion azotée des invertébrés", thesis, Bordeau.
[4] Heidermanns, C., "Zool. Jahrb., Abt. allgem. Zool. u. Physiol"., **58**, 57 (1937–38).
[5] Bahl, K. N., *Quart. J. Micro. Sci.*, **85**, 343 (1945).
[6] Abdel Fattah, R. F., *Proc. Egypt. Acad. Sci.*, **10**, 36 (1954).
[7] Cohen, S., and Lewis, H. B., *J. Biol. Chem.*, **180**, 79 (1949).
[8] Potter, V. R., and Elvehjem, C. A., *J. Biol. Chem.*, **114**, 495 (1936).
[9] Brown, H., *J. Biol. Chem.*, **158**, 601 (1945).

Electrical Noise from 'Polarization Cells' and from Human Tissues

In electromyography, metal electrodes are attached to the skin to detect the electrical changes associated with the activity of the underlying muscles. It has often been stated that a resting muscle is 'electrically silent'. However, if the amplifier noise is reduced sufficiently, electrical fluctuations of a random nature with an amplitude of about 5 μV. (peak to peak) are observed even when the subject is lying comfortably at rest on a bed[1]. The first possible explanation that comes to mind is that these fluctuations represent the random thermal noise of the source, which in this case is the skin and muscle tissue in series with the electrodes. This suggestion has been tested by simultaneous measurements of the impedance between the electrodes and the spectrum of the fluctuations.

Analysis of measurements of the impedance of the tissues with the aid of Cole impedance diagrams[2] before and after rubbing away the horny layer of the skin confirmed that the skin and underlying tissues could each be represented by a fixed resistance in parallel with a 'polarization cell' containing a resistance and capacitance the values of which were dependent on frequency. The next problem was, therefore, to estimate the noise produced by a 'polarization cell'. This was investigated experimentally. A stainless-steel concentric needle electrode, consisting of a hypodermic needle 0·64 mm. in diameter with a central wire 0·126 mm. in diameter, insulated by 'Araldite' cement, dipped into 1 per cent sodium chloride, was chosen as a convenient 'polarization cell' the impedance of which was almost entirely attributable to the metal-solution interfaces and only to a negligible degree to the resistance of the electrolyte. The impedance was measured at a given frequency at a current density of a few m.amp. per sq. cm. of electrode area, and the noise generated by the cell in a narrow band centred at that frequency was determined with the aid of the low-noise amplifier and a Muirhead–Pametrada wave analyser. The cell was then replaced by its equivalent impedance consisting of a resistance in parallel with a condenser, and the noise again measured; this was found to be equal within the expected error of the measurements (about 4 per cent), to the noise produced by the cell, in the range 125–4,000 c./s. At higher frequencies the noise produced by the cell was too small to observe above amplifier noise. At lower frequencies the cell produced more noise than the equivalent impedance. This was probably caused by slight movements of the needle set up by vibration; the discrepancy was reduced, though not eliminated, by fixing the needle more rigidly to the vessel containing the solution. It was concluded tentatively that the component at a given frequency of the noise produced by a 'polarization cell' is equal to the component of the thermal noise arising from the equivalent impedance measured at that frequency. Incidentally, this confirms an observation made by Wien as long ago as 1896[3] that the impedance of a metal-electrode system is independent of the current density up to a certain limit of a few m.amp. per sq. cm. (Above this limit the impedance decreases with increasing current density.) Indeed, the noise measurement may be regarded as a method of determining the impedance at the lowest possible current density, that is, the current density caused by thermal agitation.

Since the frequency-dependent component of the tissue impedance may have a physical basis similar at any rate in part to a polarization impedance, it seemed reasonable to expect that the tissues would generate the thermal noise which could be calculated from the values of their measured impedance. In fact it was found that the tissue noise was greater than this expected value, particularly at low frequencies. Measurements with surface electrodes 1 cm. in diameter before and after rubbing away the horny layer of the skin made it possible to show that both skin and underlying tissues contributed to the 'excess' fluctuations. Spectra of the excess fluctuations for three different subjects, for rubbed skin, are shown in Fig. 1. Above about 1,000 c./s. the components of the fluctuations were too small to measure in the presence of the amplifier noise. Excess fluctuations were also found when the needle electrode was inserted into a resting muscle.

It is possible that the excess fluctuations are caused in part by small movements of the electrodes relative to the tissues, by fluctuating streaming potentials set up by the ebb and flow of blood in the small vessels[4], by the miniature end-plate potentials

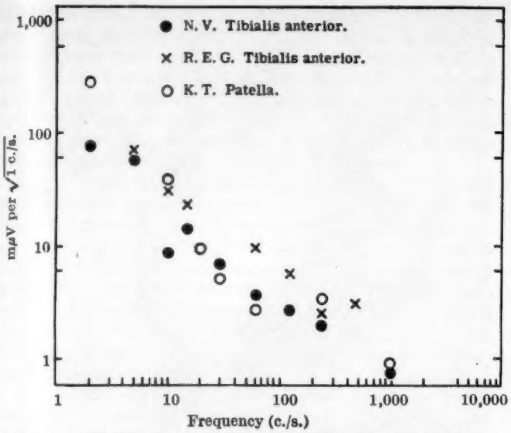


Fig. 1. Spectra of the excess fluctuations detected by silver suction electrodes 1 cm. in diameter, placed 5 cm. apart on the sites indicated. The skin was scraped with fine sandpaper to remove the horny layer, and rubbed with electrode jelly before the electrodes were attached. The excess fluctuation is the total observed fluctuation less the contributions caused by amplifier noise and thermal noise in the tissue impedance. The ordinate represents the square root of the mean square potential difference in a band 1 c./s. wide

reported by Fatt and Katz[5], by the 'biological noise' reported by Brock, Coombs and Eccles[6], and by discharges in sensory nerve fibres. The fact that they are found when the electrodes are placed over non-muscular sites such as the patella suggests that they are not caused by the continuous firing of a few motor units in a muscle. This result is of interest in relation to the hypothesis that muscular 'tone' is caused by just such a background of active contraction, persisting in a normal muscle even when resting, and supports the view expressed by Ralston[7] that this classical concept of tone should be reconsidered.

A. NIGHTINGALE

Physics Department,
Guy's Hospital Medical School,
London Bridge, S.E.1.

[1] Joseph, J., Nightingale, A., and Williams, P. L., *J. Physiol.*, **127**, 617 (1955).
[2] Cole, K. S., *J. Gen. Physiol.*, **12**, 29 (1928).
[3] Wien, M., *Ann. Phys. u. Chemie*, Neue Folge, **58**, 37 (1896).
[4] Bull, H. B., "Physical Biochemistry", 165 (Wiley, New York, 1943).
[5] Fatt, P., and Katz, B., *J. Physiol.*, **117**, 109 (1952).
[6] Brock, L. G., Coombs, J. S., and Eccles, J. C., *J. Physiol.*, **117**, 431 (1952).
[7] Ralston, H. J., *Amer. J. Phys. Med.*, **36**, 94 (1957).

Nervous Control of Cilia in Amphioxus (*Branchiostoma*)

ONE of the clearest cases of the nervous control of cilia was provided by Fedele's[1] work upon the cilia of the gill bars of the pelagic tunicate *Doliolum*; in the sessile tunicates also it seems that the gill bar cilia may be inhibited by the peripheral nervous system, for they may be observed to beat intermittently in the intact animal, and D. B. Carlisle (personal communication) has found that several species of sessile ascidian occasionally show both branchial apertures open with no water current passing through the atrium, that is, the gill bar cilia are presumably at rest. Knight-Jones[2] has shown that in the Enteropneusta the gut cilia exhibit bursts of activity alternating with periods of rest; in this group, the gill bar cilia also appear to be under the control of the nervous system.

It is interesting that all these animals are more or less closely related to the Acrania, and that all feed in a somewhat similar manner. It is not surprising that in amphioxus also the cilia producing the feeding current are under nervous control. In amphioxus, however, the evidence is perhaps more striking, for ciliary inhibition may be produced by a specific stimulus, and it may be observed in the intact animal; in dissected preparations (as, for example, in the experiments upon the Enteropneusta), the dissection inevitably involves derangement of the normal blood supply to the ciliary tissue, and it is not certain, therefore, that the ciliary inhibition may not be a secondary effect.

When a small amphioxus is placed in a Petri dish of sea-water under a binocular, the lateral cilia of the gill bars are clearly visible through the transparent body-wall. Even in the largest animals some of the gill apparatus is visible. When the animal is anæsthetized with dilute solutions of benzamine hydrochloride, magnesium chloride, or urethane, all the lateral cilia of the gill bars exhibit metachronal beat, of the kind discussed by Knight-Jones[3].

Isolated parts of the gill apparatus also show metachronal beat when anæsthetized.

In the normal animal, which has been feeding, it is invariably the case that some parts of the gill apparatus do not exhibit metachrony. The cilia of some parts of some gill bars or of all of some gill bars are either found to be at rest or else feebly vibrating non-metachronously. Upon the addition of anæsthetic, the parts of the gill apparatus which are at rest begin to beat and soon achieve metachrony.

In the normal unanæsthetized animal, certain stimuli, for example, the addition of carmine suspensions to the water, result in complete or nearly complete cessation of ciliary beat. This takes place rapidly; a minute after the carmine particles have entered the atrium, all the cilia are at rest. If the animal is now placed in an anæsthetic, metachronal beat is resumed as soon as anæsthesia has proceeded so far that the reflex responses of the buccal cirrhi and velar tentacles have been abolished. Addition of carmine suspensions to anæsthetized animals does not inhibit the metachronal beat.

These facts strongly suggest that the lateral cilia of the gill bars (those chiefly instrumental in producing the feeding current) are under nervous control, and that this control is inhibitory upon a fundamental metachronal rhythm. It is interesting that other ciliary tracts which are concerned in a subsidiary way with the feeding process, the wheel organ and the pharyngeal cilia of the gill bars are never observed to stop beating under any stimuli such as the addition of carmine particles.

It is less easy to observe the cilia of the gut in the intact animal, but in very small specimens the metachronal beat of the gut cilia can be observed; it does not appear to alter when the lateral cilia of the gill bars are inhibited.

The significance of the nervous control of the cilia producing the feeding current in the normal life of the animal is not certainly known, but it is probable that it is related, as Rice[4] long ago suggested, to intermittent patterns of activity in the feeding process. He supposed that amphioxus alternated feeding periods with periods of rest when it hid beneath the sand, and pointed out that this hypothesis implied that the animals could in some manner control the rate of beating of the cilia producing the feeding current.

The manner in which this control is exerted is extremely obscure; it is not known, for example, whether the rate of beat is controlled, or whether the control is simply of an on–off type. In amphioxus, unlike the other early chordate-like groups in which nervous control of cilia has been suggested, the peripheral nervous system is fairly well known; Dogiel[5] and Kutchin[6] have shown that there are many multipolar nerve cells lying upon the gill bars, and under the endostyle; I have shown that it is probable that these cells are connected with the central nervous system by their own axons[7]. That metachrony is not resumed at the same parts of the gill bars where it was first inhibited, when an animal that has been in a carmine suspension is placed in anæsthesia, does not suggest that the inhibition can be a local effect, related to the dendrite fields of particular neurons.

A detailed account of these observations will be published elsewhere with other observations upon the muscular patterns in the feeding process of amphioxus.

Quentin Bone

Department of Zoology and Comparative Anatomy, Oxford.

[1] Fedele, M., *Pubbl. Staz. Zool. Napoli*, **4** (1923).
[2] Knight-Jones, E. W., *Proc. Zool. Soc. Lond.*, **123**, 637 (1952).
[3] Knight-Jones, E. W., and Millar, R. H., *Nature*, **163**, 137 (1949).
[4] Rice, H. J., *Amer. Nat.*, **14**, 1, 73 (1880).
[5] Dogiel, A. S., *Anat. Hefte*, **21**, 145 (1902).
[6] Kutchin, H. L., *Proc. Amer. Acad. Sci. Art.*, **49**, 571 (1913).
[7] Bone, Q., *Quart. J. Micro. Sci.* (submitted for publication).

Neurosecretory Cells in some Cirripedes

The occurrence of neurosecretory cells or their products has not hitherto been demonstrated in the Cirripedia. By analogy with the situation in many other crustaceans the neurosecretory organs of which have recently been the object of much investigation, control of many of the metabolic processes in the Cirripedes might be expected to be under hormonal control originating in neurosecretory activities[1].

We have recently shown the presence of typical neurosecretory cells containing abundant granules (Fig. 1) that stain deeply with the paraldehyde–fuchsin of Gabe's modification[2] of Gomori's technique. In *Pollicipes polymerus* J. B. Sowerby, the cells are large (about 30–40μ largest diameter) and prolific in the sub- and supra-œsophageal ganglia where they appear to be localized in discrete areas. Release of the granules appears to take place both through the cell membrane and by axon transport. It has been possible to follow the development of these cells and the formation and discharge of the granules. Further, cross-sections of the sub-œsophageal, but no other ganglion, show discrete paired areas where the deeply staining granules are concentrated and nuclei are absent.

The following operculate barnacles have also been examined, *Balanus glandula* Darwin, *B. hesperius lævidomus* Pilsbry, *B. nubilis* Darwin, *B. rostratus* Hoek and *Chthamalus dalli* Pilsbry. In all these, deeply staining granules are found in the major ganglia but the neurosecretory cells are much smaller and less well defined than in *Pollicipes polymerus*; this could be related to the season when collected.

The investigation of neurosecretion in the Cirripedia would seem to offer a new and profitable approach to many problems of their physiology and ecology. Further, since most of the species, unlike almost all other crustacean groups, are hermaphrodite and yet normally cross-fertilizing, the relation of their neurosecretory activities to their reproductive activities presents problems of unusual interest, as does its relation to the uncommon moulting behaviour.

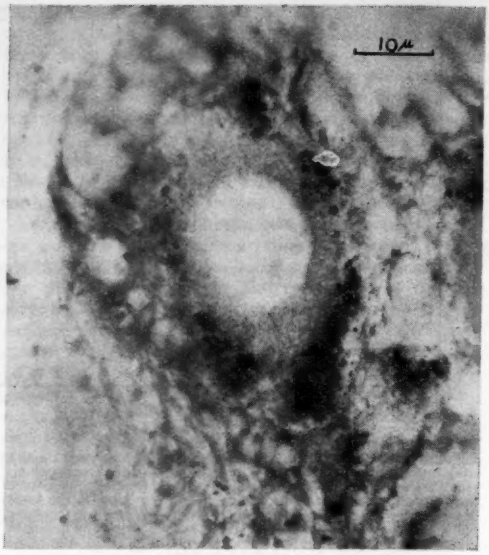


Fig. 1. *Pollicipes polymerus* J. B. Sowerby. Photomicrograph (green light) taken from transverse section of ganglion showing large neurosecretory cell. Paraldehyde–fuchsin stained; note large unstained nucleus and numbers of deeply staining granules around periphery, in blood spaces and in the axon hillock

A detailed account of this work and the results of further related observations will be published elsewhere.

H. Barnes*
J. J. Gonor

The Marine Station, Millport, Scotland, and
The Friday Harbor Laboratories, University of Washington, Seattle.

* Supported by a grant from the Office of Naval Research (Contract No. *NR*165/142).

[1] Knowles, Sir Francis G. W., and Carlisle, D. B., *Biol. Rev.*, **31**, 396 (1956).
[2] Gabe, M., *Bull. Micro. App.*, (2), **3**, No. 11–12, 153 (1953).

Connective-Tissue Pigment of the Centipede, *Lithobius forficatus* (L.)

The connective-tissue pigment of the centipede *Lithobius forficatus* is violet in colour and occurs in abundant granules in the connective tissue cells[1]. Little is known of its nature and properties. On dissecting the animal[2] it was noticed that the intensity of colour increased, implying that *in vivo* some of the pigment is in a colourless, reduced form. Interest in the pigment was renewed by the demonstration of a tissue-pigment with a redox colour change in the isopod Crustacea[3]. The pigment cells of the latter are of mesodermal origin, like those of *Lithobius*.

The pigment has been extracted by mild treatment and further purified by precipitation and chromatographic procedures. The absorption spectrum of the oxidized form, in neutral aqueous medium, shows a peak around 580 mμ and a trough around 495 mμ.

With decrease in wave-length beyond this point absorption increases, without incident, to a peak at 258 mμ, probably indicating the presence of nucleic acid. There is a shallow trough at 245 mμ, beyond which point absorption increases sharply. The reduced pigment is pale yellow in colour; in the visible range its absorption of light shows a monotonous increase as wave-length decreases.

The colours, and the absorption spectra of oxidized and reduced forms in the visible range, resemble those of hæmocyanin[4]. The resemblance extends also to solubility properties, both being soluble in water and being precipitated at about *p*H 5·0, the isoelectric point of a protein moiety. Phenolic amino-acids and arginine are demonstrable in the unhydrolysed pigment of *Lithobius*. It also contains about 0·2 per cent copper, that is, approximately the same concentration as in hæmocyanin.

The pigment therefore may prove to be a 'cytocyanin', related to hæmocyanin as myoglobin and the cytochromes are related to hæmoglobin. Until recently no such intracellular copper-pigment was recognized[4]. It is now known[5] that a number of copper-containing enzymes and pigments are closely related to hæmocyanin in colour and composition, and may occur intracellularly. The *Lithobius* pigment probably differs from these in its high concentration in the body and possibly in acting as a normal oxygen-mediator for the tissues generally, which carry a rich investment of the pigment-tissue. *In vitro* it is rapidly and reversibly reduced by chemical reducing agents, including ascorbic acid, but it remains oxidized down to very low oxygen tensions. It catalyses the oxidation of hydroquinone, though not of tyrosine. It appears to be an active redox agent *in vivo*.

The pigment differs from hæmocyanin in several essentials. The colour is normally violet, and not blue, and the absorption spectrum in the visible range differs in detail. In the ultra-violet range the spectrum differs considerably, showing peaks at 346 and 278 mμ in hæmocyanin[4]. The 278-mμ peak indicates a higher percentage of protein than in the *Lithobius* pigment, and this is confirmed by the estimation of total nitrogen. The pigment is more stable than hæmocyanin, for example, towards strong alkali; it is not decolorized by carbon monoxide or by hydrocyanic acid and is only slowly destroyed by trichloracetic acid at 95° C. It withstands boiling for a long period: in this it resembles phosphoproteins and, in fact, contains abundant phosphorus. Like phosphoproteins it redissolves on the acid side of its isoelectric point, giving an apricot-coloured solution. The hæmocyanin of *Helix* remains greenish-blue under this condition.

I am greatly indebted to colleagues in the Department of Biochemistry for the use of spectrophotometers.

A. E. Needham

Department of Zoology and
Comparative Anatomy,
University Museum,
Oxford.
Oct. 28.

[1] Attems, C. G., Kukenthal's "Handbuch der Zoologie", 4 (1) (De Gruyter, Berlin, 1930).
[2] Needham, A. E., *Proc. Zool. Soc., Lond.*, A, 115, 355 (1945).
[3] Needham, A. E., and Brunet, P. C. J., *Experientia*, 13, 207 (1957).
[4] Redfield, A. C., *Biol. Rev.*, 9, 175 (1934).
[5] Redfield, A. C., in "Copper Metabolism", edit. by McElroy, W. D., and Glass, B. (Johns Hopkins, Baltimore, 1950).

A Two-stage Transfer of Pathogenicity between the *MEL* and *NWS* Strains of Influenza A Virus

In genetic interaction between the *MEL* and *NWS* strains of influenza *A* virus it is convenient to regard the production of specific lesions in the chick embryo and pathogenicity for the mouse which has been inoculated intra-cerebrally with the virus as separate heritable characteristics, both of which are transferable from *NWS* to *MEL*[1]. It has been a feature of Australian work that recombinant, *N–M*, strains produced by double infection of the allantoic cavity of the chick embryo are not pathogenic for the mouse (Fraser, K. B., and Burnet, F. M., unpublished work). On the other hand, American work records combination forms, produced in the fertile egg, which are virulent for the mouse[2], but the methods of production of *N–M* strains in the two laboratories are not strictly comparable. Our techniques concentrated on limiting the time of virus production to a short infectious cycle of about eight hours, which was initiated in the washed allantoic cavity[3] and from which the original inoculum was largely removed before the new yield became available, whereas American methods used both the washed and the intact allantois, variable reproductive times up to forty hours and inocula irradiated with ultra-violet. The precise source of the most virulent recombinant of the *MEL* type is not described; but in general, transfer of pathogenicity was most effective with small doses and after long reproductive cycles[2]. The most likely explanations of the failure of our hybrid strains to acquire pathogenicity to the mouse were thus the washing out of the allantoic sac or the limiting of reproduction to one cycle.

In order to investigate the results of multiple cycles of double infection, each of three hybrid *N–M* strains which had originally been isolated from double infection of the chick embryo with *MEL* and *NWS* and which were non-pathogenic on intracerebral inoculation of the mouse, was subjected, in the chick allantois, to a series of four separate growth-cycles of nine hours duration in the presence of an adequate inoculum of the pathogenic 'parent' *NWS*. Groups of three eggs were used and the presence of double-neutralizing hæmagglutinin in all eggs was taken as a criterion of successful double infection[4]. Between each cycle of infection the *N–M* strain was re-isolated from the pooled allantoic fluids of each group by two allantoic passages at the limit of infectivity in the presence of sufficient anti-*NWS* serum to neutralize $10^{4.5}$ *ID*50 of *NWS* virus. This ensured that the heterogeneous product of each infectious cycle was not passed from one pool of fluids into the next according to the following scheme:

$$\left.\begin{matrix} N\text{–}M \\ \times \\ NWS \end{matrix}\right\} \text{Pool } 1 \quad 2LD \quad \left.\begin{matrix} N\text{–}M \\ \times \\ NWS \end{matrix}\right\} \text{Pool } 2 \quad 2LD \quad \left.\begin{matrix} N\text{–}M \\ \times \\ NWS \end{matrix}\right\} \text{Pool } 3 \quad 2LD \quad \left.\begin{matrix} N\text{–}M \\ \times \\ NWS \end{matrix}\right\} \text{Pool } 4$$

$2LD$ = 2 passages at limiting infectivity in anti-*NWS* serum.
$\times$ *NWS* = 9-hr. growth cycle in the presence of *NWS*.

There were three such series, one for each strain of *N–M* virus, and a pool of three fluids was preserved from each cycle in all series. The mouse pathogenicity of limit dilution fluids from pool 4 of each series was compared with that of the original *N–M*'s in the first instance. Test fluids were grown in anti-*NWS* serum. As Table 1 shows, each fluid from the fourth

Table 1. Comparison of Intra-cerebral Pathogenicity in Mice of Original and Fourth-cycle *N–M* Virus Strains

	Starting fluids	Fourth-passage fluids
Series 1	0/6	1. = 2/6* (+ 1 sick) 2. = 3/6 (+ 1 sick)
Series 2	0/6	1. = 2/6 (+ 1 sick) 2. = 3/6 (+ 1 sick)
Series 3	0/6	1. = 3/6 (+ 1 sick) 2. = 2/6 (+ 1 sick)

* Fractions indicate dead/survivors.

pools in the three series was pathogenic to mice. To eliminate spontaneous mutation to neuro-tropism as a cause and also contamination by *NWS* virus, the same *N–M* strains in high dosage, $10^{4.0}$ *ID*50, were given four successive cycles of four days each in mouse-brain. They failed to become pathogenic to mice and no *NWS* grew.

Since *N–M* strains are pathogenic for the chick when first isolated, these results are evidence of at least a two-stage transfer of pathogenicity between the *NWS* and *MEL* strains of influenza virus. This might be expected from the distribution of virulence in recombinant influenza viruses which Burnet has stressed[5].

K. B. Fraser

Department of Bacteriology,
University Buildings,
Foresterhill, Aberdeen.

[1] Lind, Patricia E., and Burnet, F. M., *Austral. J. Exp. Biol. and Med. Sci.*, **32**, 437 (1954).
[2] Hirst, George K., and Gottlieb, Tamar, *Virology*, **1**, 221 (1955).
[3] Fraser, K. B., and Burnet, F. M., *Austral. J. Exp. Biol. and Med. Sci.*, **30**, 459 (1952).
[4] Fraser, K. B., *Brit. J. Exp. Path.*, **34**, 319 (1953).
[5] Burnet, F. M. ,and Lind, Patricia E., *Nature*, **178**, 627 (1954).

Gestational Changes in Connective Tissue in the Ewe

In a previous communication[1], various gross changes in the pelvic region of the pregnant ewe were described. Studies on pelvic relaxation in this animal have now been extended to include microscopic examination of pelvic connective tissue structures at different gestational stages.

Histological preparations were made of samples from the broad ligament of the uterus, the sacrosciatic ligament, the ischiococcygeus muscle and its tendon of origin, the fibrous portion of the sacroiliac joint, the lumbosacral joint, and the pubic symphysis. For comparison, similar tissue from an area outside the pelvic region was included, the gastrocnemius muscle and the tendon of origin of the deep flexor muscle of the lower limb being selected for this purpose. In addition, the connective tissue layers in the different parts of the urogenital tract were examined.

Several standard connective tissue stains, including a silver impregnation method, were used. Histochemical techniques were not applicable in this instance. The observations have thus been confined largely to fibroblasts and collagen fibres.

For the broad and sacrosciatic ligaments, samples were taken from a total of nine non-pregnant ewes, two in œstrus and the others in mid-cycle, 29 pregnant animals at different stages throughout gestation, and five immediately post-partum. The remaining tissues were available from four of the non-pregnant ewes and nine of the pregnant ewes at stages between 88 days and full-term.

Marked effects of pregnancy were observed in the connective tissue of the broad uterine and sacrosciatic ligaments, the ischiococcygeus muscle and the sacroiliac joint. Similar microscopic differences occurred in the connective tissue of the uterus, cervix and vagina of pregnant and of œstrous ewes, in comparison with non-pregnant animals in the mid-phase of the œstrous cycle. No such changes were seen, however, in the pubic symphysis, the lumbosacral joint, the Fallopian tubes, bladder or ureters, or in the connective tissue of the gastrocnemius muscle and the tendon of the deep flexor of the lower limb.

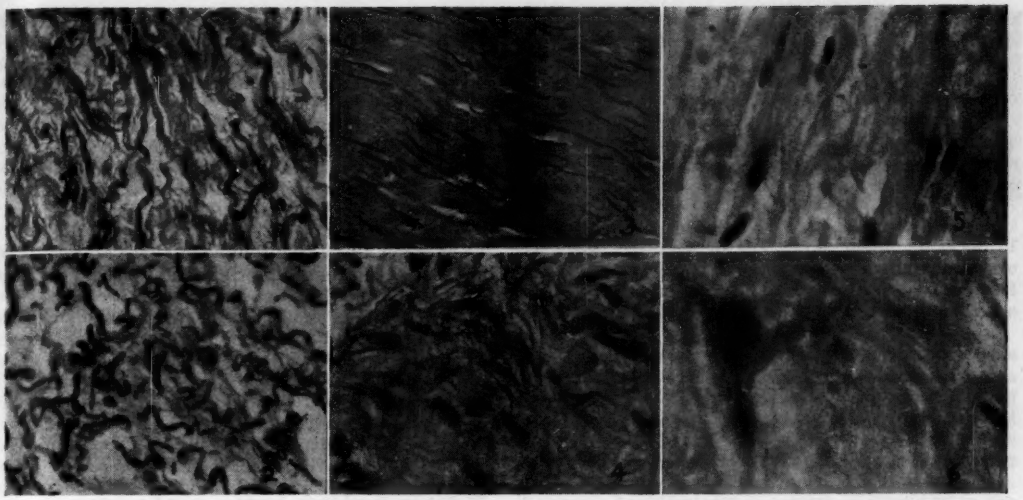
These gestational effects revealed themselves particularly in intense activity of the fibroblast cells. The most pronounced changes were seen in the broad ligament, in which the fibroblast changes were accompanied by disappearance of fibres staining with 'collagen' dyes, such as light green, and the appearance of argyrophil fibres (Figs. 1 and 2). A considerable relative increase in ground substance also occurred, the fibres and cells in sections from full-term ewes being sparsely distributed through the matrix, in comparison with preparations from non-pregnant animals. Similar, although less extensive, changes occurred in the other affected structures (Figs. 3 and 4).

In connective tissue from non-pregnant ewes, the fibroblasts consisted of small dense nuclei, with no visible cytoplasm (Fig. 5). In the broad and sacrosciatic ligaments, for which samples were available at early gestational stages, changes in the fibroblasts were apparent by 60 days. The nuclei were now oval to round and less dense than in non-pregnant preparations. These nuclear changes, which continued progressively throughout pregnancy, were associated with increasing amounts of visible cellular cytoplasm. At full-term, these cells were large, with heavily stained cytoplasm which, especially in the broad ligament, were commonly extended into long pseudopodial processes (Fig. 6).

In terms of parturition problems in the ewe, these observations are significant in that the affected tissues are chiefly those concerned in enlargement of the pelvic canal prior to parturition. Previous studies[2] showed that relaxation of the sacroiliac joints results in potential horizontal movement of the sacrum. Gross anatomical dissections (unpublished work) have indicated that the sacrosciatic ligament and the ischiococcygeus muscle are important components of the pelvic outlet in the ewe. Changes in the connective tissue of the reproductive tract are not unexpected in view of its direct role in pregnancy.

With regard to the structure of the pelvic tissues which do not change, the bony surfaces of the ischiopubic symphysis are united by a single layer of hyaline cartilage, no fibrous tissue being present; in the lumbosacral joint, the collagenous annulus lamellosus contains a sparse distribution of small pycnotic nuclei with no visible cytoplasm which do not closely resemble the fibroblasts of the other tissues described. The increased flexibility of this joint, which has previously been observed in pregnancy, may thus be an indirect effect due to changes in ligaments associated with this region.

Many histological and especially histochemical studies have been carried out on the pubic symphysis of the guinea pig and mouse in pregnancy, experi-



Figs. 1 and 2. Broad ligament. (1) Non-pregnant; collagen fibres only. (2) Pregnant, full-term; many argyrophil fibres, collagen scarce. (Silver impregnation with Weigert's hæmatoxylin and light green. × 375)
Figs. 3 and 4. Sacrosciatic ligament. (3) Non-pregnant; flattened fibroblast nuclei with no cytoplasm, dense parallel collagen fibres. (4) Post-partum; clear oval fibroblast nuclei with much cytoplasm, loosened collagen fibres. (Weigert's hæmatoxylin and van Giesen. × 375)
Figs. 5 and 6. Broad ligament. (5) Non-pregnant; small dense fibroblast nuclei with no cytoplasm. (6) Pregnant, full-term; oval-round clear fibroblast nuclei, pseudopial cytoplasm. (Weigert's hæmatoxylin and van Giesen. × 780)

mental evidence indicating that the changes are due to hormone action (see ref. 3 for reviews).

Mechanical loosening of the sacroiliac joints has been described for these species and for some other mammals, including man, in which relaxation of the pubic symphysis also occurs, and cattle. No reference can be found to microscopic gestational changes in the sacroiliac joints of any species, or to other pelvic connective tissues which might be of importance in parturition.

Other investigations concerning hormones and connective tissue have been concerned chiefly with disease processes (see ref. 4 for review). Relatively less attention has been given to the different connective tissue components in normal variations of body processes, such as pregnancy and the œstrous cycle.

Thus, in addition to their possible application to obstetrics in ewes and other mammals of social or economic importance, the findings from this investigation are of some interest in connective tissue physiology in general. It is well established that the fibroblast cells are responsible for the production of collagen fibres and that under proliferative conditions, such as tissue culture and wound healing, the fibres are at first argyrophilic, losing this capacity as they mature and acquiring instead an affinity for standard 'collagen' stains. The changes in the broad ligament of the pregnant ewe emphasize the fact that in the normal mature animal collagen is not in a static state, but under suitable stimulus is capable of reversible change, to form argyrophil fibres and vice versa. The regional specificity of response of the connective tissues suggests a differential sensitivity of fibroblast cells to the hormones of pregnancy.

Further studies are in progress, using histochemical as well as histological methods, to determine the gestational effects on other connective tissue components, such as the ground-substance and mast cells.

These investigations were carried out at the Anatomy School, University of Cambridge. A full account will be submitted for publication elsewhere.

E. G. Bassett

Ruakura Animal Research Station,
Department of Agriculture,
Hamilton, New Zealand.

[1] Bassett, E. G., and Phillips, D. S. M., *Nature*, **174**, 1020 (1954).
[2] Bassett, E. G., and Phillips, D. S. M., *N.Z. Vet. J.*, **3**, 20 (1955).
[3] Hisaw, F. L., and Zarrow, M. X., "Vitamins and Hormones", **8**, 151 (Academic Press, Inc., New York, 1950). Frieden, E. H., and Hisaw, F. L., "Recent Progress in Hormone Research", **8**, 333 (1953). Marois, M., "Controle Hormonal de la Ceinture Pelvienne et Endocrinologie Sexuelle; la problème de la relaxine" (Masson et Cie., Paris, 1953).
[4] Iverson, K., in "Connective Tissue in Health and Disease", edit. by Hansen, Asboe (Ejnar Munksgaard, Copenhagen, 1954).

Hæmoglobins in Monkeys

We recently described[1] the finding of some abnormal hæmoglobins in two species of monkeys. Work has continued since then, and we wish to report some further abnormal findings. All but one *Cercocebus albigena* were collected within a few miles of Epulu in the Belgian Congo.

The numbers examined in the different species of monkeys can be seen from Table 1.

The doubtful specimen of *Cercopithecus mona* and one of *Cercocebus albigena* are so designated in spite

Table 1

Species	No.	Result of paper strip electrophoresis of hæmoglobin solutions at *p*H 8·6
Cercopithecus mitis	2	Both normal
,, *ascanius*	3	All normal
,, *mona*	7	6 normal and 1 doubtful
,, *l'hoesti*	1	Normal
Cercocebus albigena	2	Both abnormal
,, *galeritus*	4	All abnormal
Papio doguera	1	Normal

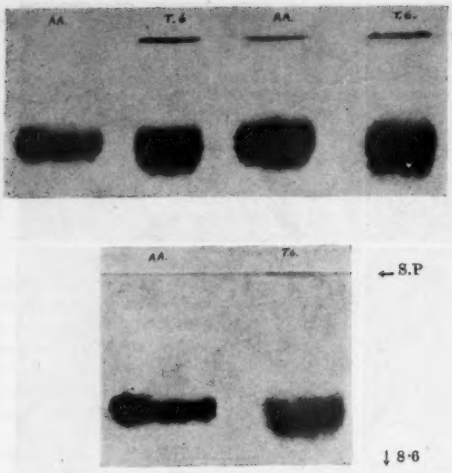


Fig. 1

of the actual numbering of the bottles. Because the hæmoglobin actually labelled as *C. mona* behaves exactly like seventeen other *Cercocebus albigena* samples we have assumed that the numbers were inverted in the field. Both animals were shot on the same day.

Cercopithecus mona. One specimen (*T*.6) gave a blurred pattern and appeared to have a forward component running slightly faster than the normal. This blood was in poor condition when it arrived in the laboratory and contained quite an amount of methæmoglobin. However, since methæmoglobin usually causes slowing of a specimen at *p*H 8·6, it seems probable that this specimen does contain a fast-running component. Its true position on electrophoresis remains uncertain. Fig. 1 shows *T*.6 in comparison with a normal blood.

Cercocebus galeritus. All four specimens from this species (which included a mother and son) were identical in pattern. The hæmoglobin separated into two distinct components. The faster component was the smaller of the two and lay just behind the normal position in the same place as the abnormal hæmoglobin of *Cercocebus albigena*. The slower component was the larger of the two and lay just behind human hæmoglobin *S* or *D*. Fig. 2 shows a sample of hæmoglobin from *Cercocebus galeritus* (*T*.12) running between human sickle-cell trait on the left and a normal blood on the right.

Cercocebus albigena. Both specimens were abnormal and showed exactly the same pattern as the sixteen specimens from this species previously described[1]. Since our earlier communication was written, a sample of *Cercocebus albigena* has been sent to Dr. H. Lehmann. He reports that on paper

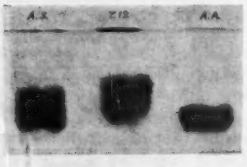


Fig. 2

electrophoresis at *p*H 8·6 it lies slightly nearer the normal or *A* position than human hæmoglobin *G*.

The solubilities of the hæmoglobin solutions from seven *Cercocebus albigena* were determined in 2·58 *M* phosphate buffer; they were 2·60, 2·66, 2·72, 1·63, 2·23, 2·84, 2·32 gm./litre. The hæmoglobin solubilities of six *Cercopithecus ascanius* were: 2·65, 2·23, 2·76, 2·07, 1·51, 2·09 gm./litre. It seems that the slow-moving hæmoglobin of *Cercocebus albigena* does not differ appreciably in solubility from the normal-moving hæmoglobin of *Cercopithecus ascanius*.

The small size of the sample of *Cercocebus galeritus* does not give enough information to decide whether the two electrophoretic components are the effect of alleles or or fixation of genes at one or more loci. The second condition has not been observed in man. If the first is the case, both alleles are probably of high frequency in the population. All four specimens were part of the same group and were collected on the same day. The collection of more animals of this species would be of great interest.

If it should prove possible to cross-breed these two species of mangabeys, more evidence on the genetic control of their hæmoglobins could be accumulated. Zuckerman[2] has reported numerous examples of viable hybrids of different species, and even genera, from the records of zoological gardens. At present the chromosomal complements of both species are being studied to assess their suitability for hybridization experiments.

This study was assisted by a grant from the Wenner-Gren Foundation for Anthropological Research.

G. F. Jacob

Medical Laboratory,
Uganda.

N. C. Tappen

Department of Anatomy,
Emory University, Atlanta, Georgia.

[1] Jacob, G. F., and Tappen, N. C., *Nature*, **180**, 241 (1957).
[2] Zuckerman, S., "Functional Affinities of Man, Monkeys and Apes" (Kegan, Paul, Trench and Trubner, London, 1933).

Hormonal Regulation of Reproduction in the Milkweed Bug, *Oncopeltus fasciatus* (Dallas)

Reproductive processes in insects are controlled by hormones[1]. The corpus allatum has for some time been known as an organ of internal secretion necessary for the normal development of eggs in many insects; in some species it also influences the secretion from accessory sex glands. The medial groups of neurosecretory cells in the brain have been demonstrated to have a hormonal influence on egg development in the fly *Calliphora*[2].

In the milkweed bug, *Oncopeltus fasciatus*, the corpus allatum is an unpaired organ situated closely behind the corpora cardiaca and the hypocerebral ganglion. This organ complex, which is intimately associated with the walls of aorta, has nervous connexions with the pars intercerebralis region of the brain, the subœsophageal ganglion, the stomodæal nervous system, and probably the tritocerebrum. The nervi corporis cardiaci I originate from two groups, each consisting of five neurosecretory cells, close to the median line in the pars intercerebralis region of the brain. These cells, the so-called *A* cells[3], which stain dark purple with the aldehyde-fuchsin technique, are visible in the living adult, and are distinct from other types of neurosecretory cells in the brain. Extirpation of the *A* cells was tried in 149 females, adult age

less than 1 hr.–2 days, and in 59 males, adult age 2–12 hr. The operated animals were kept separately at about 30° C. Of the operated females 48 survived and were killed at intervals of 10–146 days after the operation. 18 males survived and were examined at intervals from 10–80 days after the operation. 43 of the surviving females produced mature eggs, and in the males the reproductive organs looked normal. Thus the extirpation of these cells, when performed in young adults, does not prevent egg development, a result which is supported by similar experiments in phasmids[4]. Quantitative differences, namely, a reduction in the number of eggs produced, were observed in females deprived of the *A* cells as compared with normal animals or with operated controls. In females with a complete removal of the *A* cells, corpus allatum was usually of subnormal size. As in *Calliphora*[2], the neurosecretory cells in the brain seem to activate the corpus allatum.

In females allatectomized during the first day of adult life, normal egg development did not take place, and secretory material was not visible in the oviducts. Implantation of one corpus allatum taken from a sexually mature donor induced egg development in allatectomized individuals. Thus the corpus allatum seems to be necessary for normal egg development and oviducal secretion in *Oncopeltus*. The reproductive organs of allatectomized males had a normal appearance.

Starvation usually prevents egg development in *Oncopeltus*. This is due to an insufficiency of corpus allatum in starved individuals. Implantation of one corpus allatum taken from a sexually mature donor induces egg development in animals deprived of food[5].

The regulatory function of the corpus allatum in starved females was studied in a series of experiments performed on animals during the first day of adult life. The operated specimens were given only water and were examined 10 days later. Implantation of one corpora cardiaca–corpus allatum complex taken from a newly emerged female induced egg development in 10 out of 20 surviving specimens. The results obtained after implantation of a complex consisting of brain, subœsophageal ganglion, and corpora cardiaca–corpus allatum from a newly emerged specimen depended upon the innervation of the corpora cardiaca–corpus allatum complex in the implant. If the connexions between this complex and the head ganglia were severed before implantation, 16 out of 28 specimens produced eggs, whereas this happened in only 4 out of 24 females which received implants where the nerves were left intact. Other experiments where the starved female had its own corpus allatum denervated also resulted in a stimulation of egg development. Thus in starved female *Oncopeltus* the corpus allatum seems to be inhibited by its nervous connexions to the brain.

It has been emphasized that the corpus allatum is not an autonomous organ, but that its activity is under the control of the central nervous system[6]. The present report indicates that in *Oncopeltus* this holds for both fed and starved females.

A. S. Johansson

Zoological Laboratory,
University of Oslo.

[1] Scharrer, B., "The Hormones", 3 (New York, 1955).
[2] Thomsen, E., *J. Exp. Biol.*, **29**, 137 (1952).
[3] Nayar, K. K., *Biol. Bull.*, **108**, 296 (1955).
[4] Dupont-Raabe, M., *Arch. Zool. Exp. Gén.*, **89**, 128 (1952).
[5] Johansson, A. S., *Nature*, **174**, 89 (1954).
[6] Wigglesworth, V. B., "The Physiology of Insect Metamorphosis" (Cambridge, 1954).

Laboratory Variations in Mortality of the Mosquito, *Culex fatigans* Wied., exposed to DDT

It is a common experience that in the same laboratory the susceptibility of test insects to insecticides varies from one occasion to another, but few attempts appear to have been made to study the causative factors in detail. In these laboratories, we have investigated the variation in the susceptibility of *Culex fatigans* Wied. to DDT since September 1949. In view of the recent communication of Burnett[1] describing the influence of atmospheric humidity on the mortality-rate of mosquitoes exposed to certain residual insecticides, our results may be of interest.

Our experiments were carried out with the insects drawn from a colony which was established from a single egg raft on September 17, 1945[2]. The breeding of insects as well as the assay of toxicity were carried out in a partially conditioned room in which, while the variations in temperature and humidity during any one day or succeeding days were not appreciable, they varied particularly in respect of humidity in the different months or seasons of the year. Over a period of seven years ending September 1956, the temperature and relative humidity ranged between 80° and 90° F. and 48 and 92 per cent respectively. Female mosquitoes 40 ± 5 hr. old were exposed at fortnightly intervals to filter papers impregnated with solutions of pure *pp'*-DDT in liquid paraffin in varying concentrations. The contact period was 1 hr., and observations on mortality were recorded 24 hr. afterwards. The mortality of mosquitoes in the control sets was nil. In Fig. 1 are presented the values of *LD*50 and of relative humidity and temperature on the days of assessment. For comparison with Burnett's results[1], the rainfall also has been indicated.

The results show that while such variations in temperature as there have been cannot account for the rise and fall in the values of *LD*50, relative humidity has a positive role. With higher humidities, particularly during the period of August–October in any year, greater values of *LD*50 are registered. With lower humidities during November–February the values for *LD*50 are also lower. In this connexion, the results obtained by Barlow and Hadaway[3] are of interest.

In order to provide confirmatory proof of the role of humidity in influencing the mortality, two experiments were conducted at the same temperature, 29 ± 1° C., but at two different controlled levels of humidity: 49 ± 6 per cent and 88 ± 4 per cent. Pupæ of *C. fatigans* drawn from the laboratory culture were placed in the respective humidity cabinets, and on emergence the adults (40 ± 5 hr. old) were exposed to the filter papers impregnated with varying concentrations of *pp'*-DDT. Dosage–mortality relationship is shown in Fig. 2. It will be seen that humidity bears an inverse relation to the mortality affected.

The work of Burnett[1] and the earlier work of Bordas and Navarro[4] have shown that with dieldrin and BHC the susceptibility of certain species of *Anopheles* is enhanced by an increase in relative humidity. The results described above with DDT using *C. fatigans* show a reverse trend. The difference can perhaps be understood on the basis of two competing influences coming into operation. One of these is connected with the availability of the insec-

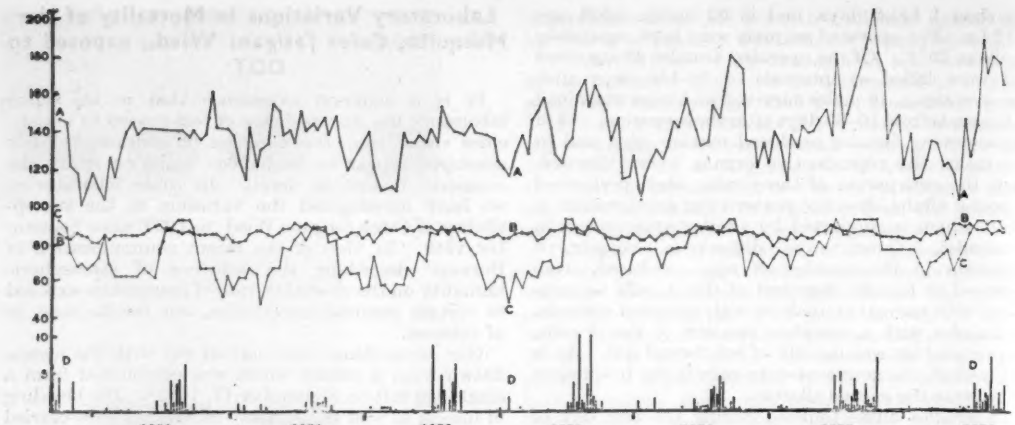


Fig. 1. Laboratory variations in mortality of the mosquito, *Culex fatigans* Wied., exposed to DDT at fortnightly intervals. *A*, *LD*50 mgm./ft.²; *B*, temperature (° F.); *C*, relative humidity; *D*, rainfall. (• denotes trace)

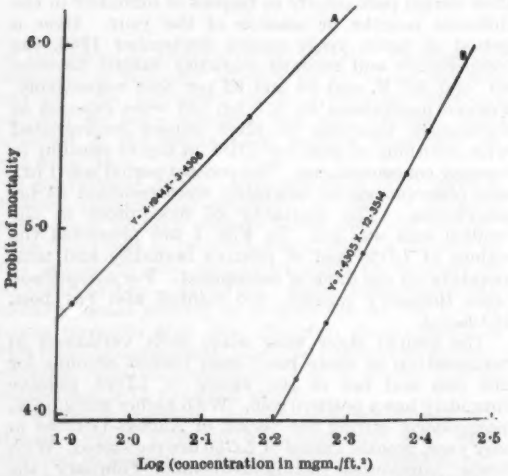


Fig. 2. Contact toxicity of *pp'*-DDT in liquid paraffin to *Culex fatigans* Wied. *A*, 29° C. ± 1° and 49 ± 6 per cent relative humidity; *B*, 29° C. ± 1° and 88 ± 4 per cent relative humidity

ticide on the surface treated, and the other is the variation in susceptibility of the test insect on account of the humidity of the environment. It appears that in Burnett's field trials[1] the former of the two factors takes a predominant role whereas in the experiments now reported the second factor takes the lead. Further work is in progress.

We thank Mr. Ali Ausat for technical assistance, and we are indebted to Dr. T. S. Subramanian, former chief superintendent of these laboratories, for interest in the work.

T. Koshi
S. K. Ranganathan

Technical Development
Establishment Laboratories,
Kanpur.

[1] Burnett, G. F., *Nature*, **177**, 663 (1956).
[2] Newman, J. F., Aziz, M. A., and Koshi, T., *Proc. Ind. Acad. Sci.*, **30** B, 61 (1949).
[3] Barlow, F., and Hadaway, A. B., *Nature*, **178**, 1299 (1956).
[4] Bordas, F., and Navarro, L., W.H.O. (Insecticides), **38** (Geneva, 1955).

Reversibility of the Red – Far-red Reaction by Irradiation at Different Sites

Since the discovery that red light promotes and far-red light inhibits the germination of lettuce seeds[1,2] this reversible photoreaction has been studied in detail[3,4] and has been found to be identical with that involved in controlling flowering and other biological processes. Because of the widespread occurrence and importance of this reaction, a detailed understanding of its mechanism is of the utmost importance, and attempts to explain it have been made by a number of workers. Most recently, the available knowledge has been summed up by Hendricks in a formula of general terms[5]. The form in which this process is usually stated makes it appear that the same pigment molecules which, for example, have been brought to the far-red absorbing form by red radiation are directly reversed to their former state by the absorption of far-red light.

In all the experiments upon which this type of explanation is based, red and infra-red light were always given on the same side of the seeds. In order to discover whether an illumination active in reversing a previous light effect has to be applied at the same site or not, a simple experiment was carried out, that is, the seeds were turned over between the two kinds of illumination. 50–100 lettuce seeds were laid out in rows on dry filter paper and 2·5 c.c. water added. The seeds were allowed to imbibe for two hours in the dark at 25° C. and were then exposed to red light ('Sylvania' red fluorescent tube wrapped in red 'Cellophane') for various periods between 5 sec. and 10 min., the light intensity being about 19 kilo-erg./cm.²/min. Immediately after the light treatment, the seeds were turned over with a tapered blunt spatula under a weak green safelight ('Sylvania' green fluorescent wrapped in yellow and green 'Cellophane'), while control lots were exposed to the same intensity of green light, but not turned over. Between 1·5 and 2·5 min. are required to turn over 50–100 seeds. Both the 'inverted' seeds and the controls received various amounts of far-red radiation (incandescent illumination filtered through blue and red 'Cellophane') 10 min. after the light treatment. Other controls were inverted, but not given subsequent far-red illumination.

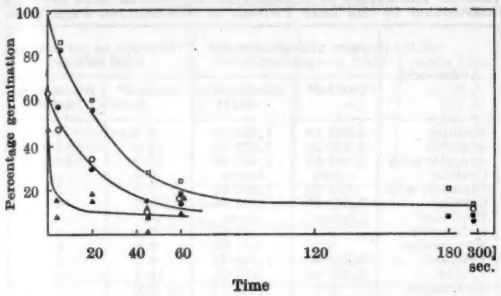


Fig. 1. Germination percentage of lettuce seeds after irradiation with red light, followed by far-red. □, Red-light treatment given for 60 sec.; ○, for 30 sec.; △, for 5 sec. Closed symbols: seeds received red irradiation on one side and far-red on the other. Open symbols: both light treatments given to same side

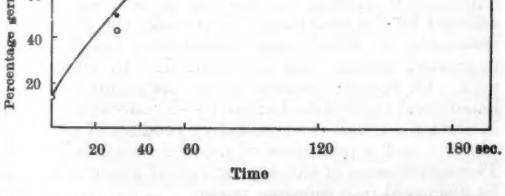


Fig. 2. Germination percentage of lettuce seeds after irradiation with far-red light for 1 min., followed by treatment with red light. Open and closed symbols as in Fig. 1

Fig. 1 shows that far-red radiation depresses the red light effect as well as, or even somewhat better, when applied on the reverse side of the seed than when given to the same side which had received the red light. The same is true for the reverse sequence of light irradiation, as can be seen from Fig. 2.

It is highly improbable that the seeds received the same amount of any irradiation on both sides owing to the optical properties of the wet filter paper. Neither can penetration of the light through the seed itself make this possible. When penetration of light through whole or bisected seeds was measured by photographing them on spectroscopic plates with the same light source as used in the experiments, it was found that at least 90 per cent of the incident light was absorbed by the seed halves.

The findings permit a number of interpretations: for example, the photoreceptor and/or photoproducts may diffuse rapidly after illumination throughout the seed. Another conclusion may be that although the photoreceptor molecules on one side of the seeds remain in the state determined by the first irradiation, illumination in a different site, that is, involving different photoreceptor molecules, will bring about reversal of the effect caused by the first illumination.

Further experiments, including the use of collimated light sources and irradiation with red as well as far-red light on both sides of the seed, will be carried out to gain more information on the system involved.

This investigation was part of the research carried out by one of us (S. K.) under the Atypical Growth Grant (*INSTR* 47H–962) to Dr. A. W. Galston, to whom our thanks for his interest and advice are due. The work of J. W. P. was supported by the John A. Hartford Foundation.

SHIMON KLEIN*
JOHN V PREISS

Department of Botany and
Department of Biophysics,
Yale University,
New Haven, Connecticut.

* Present address: Hebrew University, Jerusalem, Israel.

[1] Flint, L. H., *Science*, **80**, 38 (1934).
[2] Flint, L. H., and McAlister, E. D., Smithson. Misc. Coll., 94, 1 (1935).
[3] Evenari, M., "Radiation Biology", 3, 519 (McGraw-Hill Book Co. Inc., 1956).
[4] Toole, E. H., Hendricks, S. B., Borthwick, H. A., and Toole, V. K., "Ann. Rev. Plant Physiol.", 7, 299 (1956).
[5] Hendricks, S. B., *Amer. Scient.*, 44, 229 (1956).

Effect of Transmitted Ribonucleic Acid from Healthy Pear Trees upon the Synthesis and Composition of Protein

QUITE recently it has been shown that ribonucleic acid, derived from tobacco mosaic virus, is infectious[1,2], that is, when inoculated into plants it induces typical metabolic changes.

In a previous paper the effect of uracil upon the synthesis of ribonucleic acid and the importance of the acid for protein synthesis in fruit trees was demonstrated[3]. The question now arises whether the effect of ribonucleic acid upon protein synthesis occurs *in situ* only, or whether it is possible, considering the above reports, to induce this effect in other trees by transmitting ribonucleic acid from one tree to another. This problem was investigated by testing ribonucleic acid derived from trees in a certain physiological condition upon those in a different physiological condition.

It is well known that pear trees grafted on pear seedlings differentiate flower buds much later than do those grafted on quince. Thus, though both types of trees are of the same age, they are in different physiological stages. This provides a situation suitable for the above tests.

Leaves were collected in May at the time of natural flower-bud differentiation from bearing pear trees (grafted on quince), and the *p*H quickly determined. For the extraction of ribonucleic acid, the leaves were minced in a Waring blendor for 1 min.; sufficient ice-cold water was added to produce a crude mash which was adjusted to the previously determined *p*H of the leaves. The minced material was washed several times with ice-cold 0·1 *N* sodium chloride and then with a 3/1 mixture of cold ethanol/ether. After separation of the organic solvent phase the material was transferred to twice its volume of ice-cold 0·4 *N* sodium chloride containing 0·5 per cent sodium dodecyl sulphate, and the whole adjusted to *p*H 7·5. The suspension, frequently shaken, was then kept for 6 hr. at 4° C. The aqueous fraction was separated, and the extraction procedure was repeated once more. The aqueous fractions from both extractions were combined and ammonium sulphate added to 0·4 saturation. The protein precipitate was separated and the supernatant was now shaken with an equal volume of ice-cold water-saturated phenol. The aqueous phase containing ribonucleic acid was decanted and the phenol was extracted with ether[1,2]. The refrigerated solution was adjusted to *p*H 6·3, and the acid was precipitated by saturation with

sodium chloride. After separation the ribonucleic acid was dissolved in a *p*H 6 acetate buffer; the resulting ribonucleic acid–buffer solution was then applied to the non-bearing 'acceptor' (pear on pear) trees. The aqueous solution of ribonucleic acid was light yellowish, and Folin's phenol reagent[4] gave no indication of the presence of proteins.

The leaves of selected branches of the acceptor trees were first treated with 'Carborundum', and then immersed in the solution of ribonucleic acid, followed by gentle brushing of the leaf surface. This procedure was performed on two branches and repeated five times. Three weeks after the treatments leaves from bearing and non-bearing trees were collected. The dried leaves were then analysed for alcohol-soluble and -insoluble nitrogen fractions and amino-acid composition[5]. Table 1 summarizes the effect of the extracted and transmitted ribonucleic acid upon the soluble and insoluble nitrogen fractions of the acceptor.

Table 1. The Effect of Ribonucleic Acid from Bearing Pear-Trees upon the Total 'Soluble' and 'Insoluble' Nitrogen of Non-bearing Pear Trees

Treatment	Total nitrogen	Soluble nitrogen		Insoluble nitrogen	
	Dry matter (per cent)	Dry matter (per cent)	Total nitrogen (per cent)	Dry matter (per cent)	Total nitrogen (per cent)
Control*	1·75	0·170	9·0	1·58	90·0
Control†	1·57	0·160	10·2	1·41	89·0
Ribonucleic acid‡	2·17	0·142	6·6	2·03	93·4
Ribonucleic acid§	1·60	0·190	11·8	1·41	88·2
Standard error	0·16	—	—	0·11	—

* Leaves of untreated bearing (pear on quince) trees.
† Leaves of untreated non-bearing (pear on quince) trees.
‡ Leaves of non-bearing trees treated with ribonucleic acid from bearing trees.
§ Leaves of non-bearing trees treated with degraded ribonucleic acid (the acid was boiled with 0·5 *N* potassium hydroxide before transmittance).

It is seen from Table 1 that the transmitted ribonucleic acid markedly effects the metabolism of nitrogen in the acceptor tissue. The absorption of total nitrogen into the leaves was considerably increased; the total level of protein was increased, as well as its percentage of total nitrogen.

In order to establish whether the latter effects were the results of the biological activity of the applied ribonucleic acid, the acid was inactivated before application. Part of the extracted ribonucleic acid solution was boiled for 5 min. with 0·5 *N* potassium hydroxide. The *p*H was adjusted as outlined previously, and the solution was applied to the acceptor trees in exactly the same manner as the unboiled solution of ribonucleic acid. As seen from Table 1 the boiling of ribonucleic acid annuls its effect completely. It has been shown[3] that uracil induces the synthesis of protein when the ratio of uracil to guanine is increased. The addition of inactivated ribonucleic acid supplies uracil to the leaves but does not change the ratio of uracil to guanine and possibly therefore no protein synthesis was induced. Hence it is probable that a specific configuration of the intact ribonucleic acid is necessary to induce protein synthesis in the acceptor tree after transmission.

In a previous communication[3] it was shown that uracil affects, via ribonucleic acid, the amino-acid composition of the leaves. This was now also found true for transmitted ribonucleic acid as shown in Table 2.

Table 2. The Effect of Transmitted Ribonucleic Acid upon the Composition of the Leaf Protein of Non-bearing Pear Trees

Amino-acid	μgm. nitrogen per dry matter		Nitrogen as per cent of total nitrogen	
	Control*	Ribonucleic acid†	Control*	Ribonucleic acid†
Alanine	1,283·10	1,382·10	8·1	6·3
Arginine	1,890·25	3,073·25	12·0	14·1
Aspartic acid	3,748·85	3,466·05	23·8	16·0
Cystine	traces	traces	0·0	0·0
Glutamic acid	572·80	1,520·65	3·6	7·1
Glycine	1,398·70	932·45	8·2	4·3
Histidine	traces	traces	—	—
*iso*Leucine	0·0	842·05	0·0	3·9
Kynurenine	0·0	951·00	0·0	4·0
Leucine	1,029·40	1,448·35	6·5	6·7
Lysine	2,351·80	971·35	14·9	4·5
*nor*Leucine	0·0	1,027·15	0·0	4·8
Phenylalanine	374·00	841·50	2·4	3·9
Proline	912·00	1,013·55	5·8	4·7
Threonine	699·30	629·35	4·5	2·9
Tryptophan	342·75	822·60	2·1	3·7
Tyrosine	321·80	572·15	2·0	2·6
Valine	1,254·80	2,159·60	8·0	10·0
Unidentified	421·45	246·85	2·6	1·6

* Leaves from non-bearing (pear on pear) trees.
† Leaves from non-bearing trees which were treated with ribonucleic acid from bearing trees.

The values obtained for the amounts of the different amino-acids making up the leaf protein are greatly affected by the treatment. Especially the amount of *iso*leucine, of which only traces were found in the untreated leaves, was increased due to ribonucleic acid. Of special interest is the appearance of *nor*-leucine and a quinoline derivative—kynurenine—which in certain animals is an oxidative product of L-tryptophan[6,7] and a precursor of nicotinic acid in plants[8]. The significance of the appearance of kynurenine will be discussed in a separate paper.

The above results demonstrated the possibility of transmitting ribonucleic acid in its 'native' state from one tree to another; the transmitted acid then causes certain changes in the synthetic activity of the acceptor tree. Hence one might consider whether there are not certain similarities between the effect of normal and viral ribonucleic acid, the 'normal' and 'abnormal' activities of a plant being often only a matter of degree.

B. Kessler

Division of Horticulture,
Agricultural Research Station,
Rehovot, Israel.

[1] Gierer, A., and Schramm, G., *Nature*, **177**, 702 (1956).
[2] Gierer, A., and Schramm, G., *Z. Naturforsch.*, **11**, b, 138 (1956).
[3] Kessler, B., *Nature*, **179**, 1337 (1956).
[4] Lowry, D. H., Rosenbrough, Nira J., Carr, A. C., and Randall, Rose J., *J. Biol. Chem.*, **193**, 265 (1951).
[5] Evans, W. C., Smith, B. S. W., Linstead, R. P., and Elvidge, J. A., *Nature*, **168**, 772 (1951).
[6] Knox, W. E., and Mehler, A. H., *J. Biol. Chem.*, **197**, 419, 431 (1950).
[7] Knox, W. E., and Mehler, A. H., *Science*, **113**, 237 (1951).
[8] Galston, A. W., *Plant Physiol.*, **24**, 577 (1949).

Planting Distance and Number of Seedlings in Rice Cultivation

For early paddy a planting distance[1] of 6 in. × 6 in. using six seedlings[2] at each spot has been recommended. But this narrow row-spacing limits the use of interculture implements like rotary weeders, thereby affecting the economy of paddy cultivation. In order to find out if the row spacing could be increased without a detrimental effect on yield, and also to determine the corresponding number of seedlings to be planted at each spot, a field experiment was designed with rice variety *N*22, planted at 6 in. × 6 in., 8 in. × 4½ in. and 12 in. × 3 in., using

Table 1. Analysis of Variance

Due to	Degrees of freedom	Variance for grain yield	Variance for straw yield
Block	3	750·3*	6,723·0
Planting distance	2	8·1	677·8
Error (*a*)	6	91·9	1,999·9
No. of seedlings	2	28·6	2,192·5
Interaction	4	231·9†	5,377·8*
Error (*b*)	18	61·5	1,220·9

* Significant at 5 per cent level
† Significant at 1 per cent level

'Lemco' agar in an atmosphere of 90 per cent hydrogen and 10 per cent carbon dioxide at 39° C. and was first isolated in association with an anaerogenic rumen strain of *Proteus*[2]. When grown in pure culture, *F. nigrescens* died out after giving rise to various atypical forms, for example, where growth occurred at isolated points on the plate; maximum growth did not coincide with points of maximum inoculation, or where growth occurred in the form of minute colourless colonies. Other workers[2] have remarked on the variability in growth of this organism. When

Table 2. Paddy Yield (oz.) per Plot

Planting distance \ No. of seedlings	Grain				Straw			
	2	4	6	Mean	2	4	6	Mean
6 in. × 6 in.	43·25	44·50	***55·00***	47·58	121·0	124·0	***151·0***	130·3
8 in. × 4½ in.	45·25	***53·25***	39·50	46·00	125·0	***190·0***	101·0	138·8
12 in. × 3 in.	***55·00***	44·00	40·25	45·42	***154·0***	118·0	99·0	123·7
Mean	47·83	47·25	44·92	46·67	131·7	144·0	117·0	130·9

Least significant difference for interaction: Grain, 3·20; straw, 14·26

two, four and six seedlings. The nine treatment-combinations were replicated four times in split plot design, with an ultimate plot-size of 6 ft. × 9 ft. Crop was harvested on October 6, 1956, ten weeks after transplanting. Results of analysis of variance of yield and of grain and straw yields are represented in Tables 1 and 2 respectively.

Only interactions were found to be significant. From a comparison of italic figures in Table 2, it is evident that distance between rows can be increased without a deleterious effect on the yield of rain-fed early rice by a corresponding decrease in the number of seedlings planted at each spot—thereby also deriving benefit of a much lower seed-rate. In other words, at a given area for a clump of rice plants, the optimum number of seedlings planted at each spot is a function of, and directly proportional to, the shorter side of planting distance.

N. K. Jain

Agronomy Laboratory,
College of Agriculture,
Banaras Hindu University,
Banaras-5.
Sept. 24.

[1] Indian Council of Agricultural Research, Annual Report, 1953–54.
[2] Ganguly, P. M., and Choudhuri, S. D., Assam Agric. Dept., Paddy Series, Bull. No. 4 (1948).

Apparent Requirement for Vitamin K of Rumen Strains of *Fusiformis nigrescens*

An organism producing coal-black colonies on blood agar has been isolated in numbers of 10^{4-5}/gm. from the rumen contents of six cows fed on kale, hay and concentrates or grass diets and from the rumens of two abbatoir-killed cows. It may therefore be a normal component of the flora of the bovine rumen.

The organism is a Gram-negative cocco-bacillus and a strict anaerobe, producing a black pigment and a foul odour from blood. The cells measure about 0·4 × 0·3–0·2μ, occurring singly or in pairs. Longer forms and chain formation were found at minimum concentrations of menaphthone. These characteristics suggest its identity with *Fusiformis nigrescens*[1]. It was grown on 10 per cent horse blood *Proteus* was inoculated into blood plates showing atypical growth, or plates inoculated with *F. nigrescens* which did not show growth after incubation for one week, good growth of *F. nigrescens* with typical colony formation developed on further incubation; control atypical plates remained the same.

Attempts were made to determine the growth-promoting factor. Filtrates of *Proteus* grown under aerobic and anaerobic conditions were added to blood plates, but no consistent stimulation was obtained. Attempts to remove a possible growth-inhibiting substance in the medium by the addition of 0·1 per cent soluble starch, 0·03 per cent ethylene diamine tetra-acetic acid and urease were without effect. Chocolate agar and laked blood[2] also failed to influence the growth of the organism.

This difficulty in cultivating *F. nigrescens* is analogous in a number of ways to that existing in the culture of *Mycobacterium johnei* without *M. phlei*. The growth of certain strains of *M. johnei* is enhanced by the addition of vitamin K to the medium[4]. An autoclaved suspension of menaphthone in water was therefore added to a blood 'Lemco' agar plate to give a final concentration of 5γ/ml. Good growth was obtained after six days incubation and *F. nigrescens* has been subcultured serially on this medium. Moreover, menaphthone was able to revive atypically growing cultures in the same manner as *Proteus*. In liquid medium dense growth was obtained after three days incubation in 1 per cent blood 'Lemco' broth + 15γ/ml. menaphthone and also at ranges of menaphthone and menaphthone sodium bisulphite of 0·25–25γ/ml. after three days. No growth or very poor growth was obtained in 'Lemco' blood broth alone, and no growth was obtained in 'Lemco' broth containing a range of menaphthone concentrations.

Preliminary experiments suggest that this requirement for vitamin K by rumen strains of *F. nigrescens* is specific, and the inhibition of the growth of *F. nigrescens* by the natural antagonist of vitamin K, dicoumarin, is competitive. Thus, inhibition occurred when the amount of dicoumarin was equal to the amount of menaphthone added at a level of 0·25γ/ml., and 1·5 times the amount of menaphthone when the latter was added at 25γ/ml.; that is, approximately equal proportions of dicoumarin/menaphthone result in inhibition at both levels.

Many organisms, including *Proteus*, are known to synthesize vitamins of the K group[5], and synthesis by rumen micro-organisms supplies the requirements of the cow for this vitamin[6]. These preliminary experiments give an example of vitamin interdependence among micro-organisms in the rumen. A more detailed study of the nutrition of *F. nigrescens* and experiments to develop a microbiological assay technique for vitamin K with this organism are in progress.

M. Lev

National Institute for Research in Dairying, University of Reading.

[1] Schwabacher, H., Lucas, D. R., and Rimington, C., *J. Gen. Microbiol.*, **1**, 109 (1947).
[2] Edwards, J. L., *J. Hyg.*, **42**, 238 (1942).
[3] Senos, G., and Mattman, L. H., *J. Bact.*, **70**, 483 (1955).
[4] Woolley, D. W., and McCarter, J. R., *Proc. Soc. Exp. Biol. and Med.*, **45**, 357 (1940).
[5] Almquist, H. J., *Physiol. Revs.*, **21**, 194 (1941).
[6] McElroy, L. W., and Goss, H., *J. Nutr.*, **20**, 527 (1941).

Importance of Photoperiod and Temperature in inducing Diapause in the European Corn Borer, *Pyrausta nubilalis* (Hbn.)

The European corn borer was first found in Ontario in 1920[1] and, until recently, was primarily a single-generation species, producing one larval brood each summer and overwintering in diapause in the final larval instar. Beginning about 1941, a marked change in the seasonal history of the corn borer occurred. The numbers of larvæ completing development without diapause and giving rise to second-generation larvæ increased until it now constitutes a substantial part of the total borer population[2]. As one approach to an understanding of this divergence in seasonal history, we initiated a study on factors in diapause in the corn borer, including environment.

The larvæ used in this study were obtained from a laboratory culture of borers that were multivoltine at normal rearing temperatures. All larvæ in the culture were reared individually in one-dram shell vials containing a modification of Beck's[3] diet. Eight successive generations have been reared at 85° F. and approximately 70 per cent relative humidity without interruption by diapause and with no apparent reduction in vigour.

In an initial experiment, groups of newly hatched borers were reared at 45°, 55°, 65°, 75° or 85° F. to determine the effect of temperature on larval development and on the occurrence of diapause. The borers reared at 45° and 55° F. died in the second instar; those reared at 75° and 85° F. developed normally and pupated, whereas those reared at 65° F. entered a diapause. These results indicate that diapause in laboratory-reared borers can be induced by controlling the larval rearing temperature. An experiment in which larvæ in each of the five instars were reared at 65° F. for one instar and at 85° F. for the remaining instars showed that the low-temperature treatment is relatively ineffective in inducing diapause unless the treatment occurs in the fifth instar. Furthermore, fewer borers enter diapause if the larvæ have been more than one day in the fifth instar at the beginning of the low-temperature treatment.

In the foregoing experiments a photoperiod of 8·5 hr. light per day was used. Failure to induce diapause in comparable numbers of larvæ under continuous illumination at 65° F. turned our attention to the possible role of photoperiod in diapause induction. Groups of larvæ reared to the end of the fourth instar at 85° F. and constant light were transferred to 65° F., and a photoperiod of 0, 4, 8, 16, 20 or 24 hr. light per day until they had either pupated or entered diapause. The results of this experiment are compared with data for photoperiods of 8·5 and 9·5 hr. light per day, and are summarized in Table 1. The number of borers entering diapause at 65° F. increased with increasing light periods up to 9·5 hr. light per day; photoperiods of 16–24 hr. light per day were relatively ineffective. A similar experiment at 75° F., in which light periods of 0, 8, 16 and 24 hr. light per day were tested, induced diapause in no larvæ.

Table 1. Influence of Photoperiod, at 65° F., on Induction of Diapause in the European Corn Borer, *Pyrausta nubilalis* (Hbn.)

Hr. light per day	Initial No. of larvæ	Percentage mortality	Survivors entering diapause (per cent)
0	37	43	0
0	50	10	7
4	44	12	32
8	45	2	59
8·5	75	7	69
9·5	65	22	96
9·5	58	7	94
16	39	3	3
20	39	8	3
24	41	2	8
24	25	16	5

The stock used in these experiments, though multivoltine at normal rearing temperatures, thus has a facultative diapause. Furthermore, it is clear that temperature and photoperiod are factors of importance in the initiation of diapause in the borer.

J. A. Mutchmor

Entomology Laboratory, Canada Department of Agriculture, Chatham, Ontario.

W. E. Beckel

Department of Zoology, University of Toronto, Toronto, Ontario.

Sept. 3.

[1] Stirrett, G. M., *Sci. Agric.*, **18**, 355 (1938).
[2] Wressell, H. B., Ann. Rep. Ent. Soc. Ontario, 83, 43 (1953).
[3] Beck, S. D., Lilly, J. H., and Stauffer, J. F., *Ann. Ent. Soc. Amer.*, **42**, 483 (1949).

Blackhead Toppling Disease of Bananas

Blackhead disease of bananas was described by Ashby[1] as occurring in Jamaica in 1915 and being caused by a nematode, identified by Cobb[2] as *Tylenchus similis* Cobb, now renamed *Radopholus similis*. It was not sufficiently serious on the Gros Michel variety in 1942 to be listed by Martyn[3] among the banana diseases of Jamaica.

Ever since Panama disease necessitated the replacement of the Gros Michel banana by a resistant variety in Jamaica, Lacatan bananas have been grown more and more extensively there, notably since the 1951 hurricane. Lacatan bananas have, however, recently been found highly susceptible to the old blackhead disease. This has been well demonstrated where an experimental acre plot of Gros Michel bananas on one estate is practically free of the disease whereas the Lacatan bananas of the same age, in the same field, are riddled with it.

The presence of blackhead disease has only been realized since high winds have uprooted a large number of banana plants without causing 'breakneck' of the pseudostems. Investigations have shown that the roots of such plants have been so extensively invaded by *Radopholus similis* that they have been killed by the entry of secondary organisms into the stele. Where infection is not very severe, plants may produce good grades of fruit, and the heaviest losses from toppling often occur in such circumstances. Present indications are that, where the disease is particularly severe, losses from toppling may not be so serious because the plants are backward in growth and bear light bunches. The roots of young suckers tend to be less heavily invaded than those of the parent plants and these healthier roots are able to assist in anchoring the parent. In the taller plants, bearing heavier fruit, this assistance is inadequate to prevent toppling.

Radopholus similis is a burrowing nematode which soon leaves tissue rotted by secondary organisms, with the result that examination of blackened roots and heads (corms) frequently yields remarkably few parasitic nematodes. To find *R. similis* readily in the banana plant it should be sought in two regions, namely, where purplish streak lesions (less than $\frac{1}{16}$ in. wide and often not more than $\frac{1}{4}$ in. long) occur on young roots and, also, at the junction of diseased and healthy tissue near the surface of the corm, which is seldom invaded to a depth of more than half an inch. Invaded tissue is isolated by the formation of wound cambium. Although able to confine the nematodes to the surface layers of the head in this way, the banana plant is unable to resist penetration into the comparatively loose-celled parenchyma of the root cortex, so that the nematodes readily enter as far as the endodermis, where secondary organisms gain access to the vascular system, resulting in death of the roots.

R. Leach

Banana Board Research Dept.,
Kingston, Jamaica.

[1] Ashby, S. F., Bull. Dept. Agric. Jamaica, **2**, 316 (1915).
[2] Cobb, N. A., *J. Agric. Res.*, **4**, 561 (1915).
[3] Martyn, E. B., Bull. Dept. Sci. Agric. Jamaica, **32** (1942).

Leucocytozoon spp. in some Hertfordshire Birds

During the course of some work on the blood parasites of birds[1] (some of which has been or will shortly be published[2]) gametocytes of several species of *Leucocytozoon* were observed in the blood of seven species of birds. In the absence of reports of the incidence of this parasite in British birds since those of Seligman and Sambon[3] (in grouse), Woodcock[4] (in chaffinches and redpolls) and Coles[5] (in thrush, blackbird, jay, pigeon, starling, moorhen and "many others") it is thought that results from the present investigation (which took place between 1953 and 1955) might be of interest.

All the birds were shot or trapped near St. Albans, Hertfordshire, and thin films of their peripheral blood (stained with Giemsa's stain) were examined under a magnification of about 100 diameters for at least 10 min. The term 'adult' in Table 1 refers to all birds which had left the nest and were able to fly.

Details of the birds which were found to be infected are recorded in Table 1. No parasites were found in nine adult and four nestling song thrushes (*Turdus e. ericetorum* Turton), eight adult and one nestling starlings (*Sturnus v. vulgaris* L.), or seven adult house sparrows (*Passer d. domesticus* L.). (Species of which fewer than five individuals were examined are excluded from this list.)

Table 1. Incidence of *Leucocytozoon* spp. in some Hertfordshire Birds

Species of bird	Age group	No. examined	No. infected	Percentage infected
Rook (*Corvus f. frugilegus* L.)	Adult	52	8	15
	Nestling	25	0	0
Jackdaw (*C. monedula spermologus* Vieill.)	Adult	27	1	4
Blackbird (*Turdus m. merula* L.)	Adult	33	9	27
	Nestling	12	0	0
Wood pigeon (*Columba p. palumbus* L.)	Adult	12	2	17
	Nestling	1	0	0
Blue tit (*Parus caeruleus obscurus* Pražak)	Adult	5	1	20
Carrion crow (*Corvus c. corone* L.)	Adult	2	2	—
Tawny owl (*Strix aluco sylvatica* Shaw)	Adult	1	1	—

The species of *Leucocytozoon* found were identified as follows: *L. sakharoffi* Sambon 1908 in rook, jackdaw and carrion crow; *L. dubreuili* Mathis and Leger 1911 in blackbird; *L. marchouxi* Mathis and Leger 1910 in wood pigeon; *L. majoris* (Laveran 1902) in blue tit; and *L. danilewskyi* Ziemann 1898 in tawny owl. This last species was found inhabiting both round and elongated host cells in the blood, whereas all the other species were found in round cells only.

It is interesting to note that no nestling birds were found to be infected. Of the 52 adult rooks examined, 48 were known to be less than one year old (because they possessed a forwardly directed tuft of feathers at the base of the beak which is lost at the beginning of the second year[6]), and all the infected birds were among this group. This suggests that infection of British rooks (and probably other species) does not occur until either just before or after they leave the nest.

I wish to thank Prof. P. C. C. Garnham for his advice and interest throughout this work.

J. R. Baker*

Department of Parasitology,
London School of Hygiene and Tropical Medicine,
Keppel Street, London, W.C.1.

* Present address: East African Trypanosomiasis Research Organization, Tororo, Uganda.

[1] Baker, J. R., Ph.D. thesis, University of London, 1955.
[2] Baker, J. R., *Parasitol.*, **46**, 308, 321, 335 (1956); *J. Protozool.* (in the press).
[3] Seligman, C. G., and Sambon, L. W., *Lancet*, 829 (1907).
[4] Woodcock, H. M., *Quart. J. Micro. Sci.*, **55**, 641 (1910).
[5] Coles, A. C., *Parasitol.*, **7**, 17 (1914).
[6] Witherby, H. F., Jourdain, F. C. R., Ticehurst, N. F., and Tucker, B. W., "The Handbook of British Birds" (Witherby, London, 1938–41).

Influence of Parasitization on Form Determination in Aphids

Parasitization of the immature stages of some insects and Crustacea is known to result in structural abnormalities in the adults. Examples from insects are the production of 'intersexes' in certain Homoptera and Hymenoptera when parasitized by Strepsiptera[1], and of 'intercastes' of ants parasitized by nematodes[2]. Unparasitized aphids intermediate in structure between alate and apterous forms have been observed and described a number of times[3], and

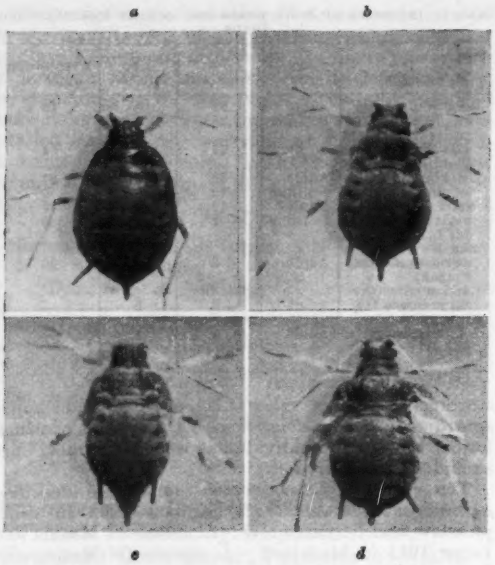


Fig. 1. Extent of suppression of alate structures in adult aphids by parasitization at different stages of development. These aphids were parasitized at (*a*) second instar; (*b* and *c*) early third instar; (*d*) late third instar

it has now been found that in *Aphis craccivora* Koch this kind of intermediate can be produced by parasitization of alatiform nymphs by the braconid wasp *Lysiphlebus testaceipes* (Cresson).

In a series of experiments, aphid nymphs which would normally have developed into alatæ were parasitized at various stages of their development, and the structural characters of the ensuing adults were observed. Until the third nymphal cutical is laid down there is no apparent structural difference between nymphs which will develop into alatæ or apteræ, and early instar alatiform nymphs were obtained by subjecting adult aphids to conditions which were known to result in the production of alatiform progeny. Adults of *A. craccivora* which had been kept for several days on cuttings of *Vicia faba* bearing only mature leaves were found to produce more than 90 per cent alatiform nymphs, whereas aphids kept on seedlings produced almost exclusively apteriform nymphs.

The extent to which alate structures were suppressed by parasitization depended upon the stage of development at which the aphids were parasitized. Aphids parasitized in the third and early fourth instars developed into intermediates in which the size of the wing pads and degree of differentiation of the thorax varied according to when they were parasitized; but they all had lateral ocelli and secondary sensoria on the antennæ, both of which are typically alate structures. Aphids parasitized in the third instar became adults without wing pads and having greatly reduced lateral ocelli and no antennal sensoria. Aphids parasitized in the first instar did not survive the fourth instar in which they had no alatiform structures and were indistinguishable from normal fourth instar apteriform nymphs except that they showed some degree of prothetely: in a number of them the form of the cauda was intermediate between those of the nymph and the adult, and they all had some typically adult pigmentation. The only apparent effect of parasitization on the structure of apteriform nymphs was in nymphs parasitized in the first instar which in the fourth instar had some adult structures.

The means by which interference with the determination of alate structure in aphids is effected is not known. Attempts to simulate the effects of parasitization by puncturing the aphids with a fine needle were unsuccessful, although severe burn injuries to parts of the abdomen of third instar nymphs did in a number of cases result in the aphids becoming intermediate between alatæ and apteræ. Ultimately form determination is probably due to the availability to the epidermal cells which produce the polymorphic structures of some substance or substances at optimum concentration at certain more-or-less critical times during development. Nutrition, which has been shown to influence form determination in a number of insects, is not likely to be involved here, as starvation of developing aphids, for example, by allowing them to develop on wilting plants, or removing them from the plants for considerable periods, merely results in smaller adults and does not cause a reversal of form. It seems more reasonable, in the light of present knowledge of the role of hormones in insect development, to suspect that the presence of the parasite causes interference with the hormone system of the nymphs. The occurrence in some parasitized aphids of prothetely, which can be caused by hormonal upsets[4], supports this, but experimental proof is lacking.

This work is being continued in the hope that it may throw some light on the mechanism of determination of form in aphids.

Bruce Johnson

Waite Agricultural Research Institute,
University of Adelaide,
South Australia.

[1] Hasson, A. I., *Trans. Roy. Ent. Soc.*, **89**, 345 (1939). Salt, G., *J. Exp. Zool.*, **59**, 133 (1931).
[2] Wheeler, W. M., *J. Exp. Zool.*, **50**, 165 (1928).
[3] Davidson, J., *J. Linn. Soc. Lond.*, **36**, 467 (1927). Stiles, K. A., *Biol. Bull.*, **74**, 430 (1938).
[4] Wigglesworth, V. B., "The Physiology of Insect Metamorphosis", (Cambridge, 1954).

Balanus tulipiformis Ellis on the Atlantic Coast of France and an Unusual Situation for *B. amphitrite* Darwin

In June 1956, a stone carrying a large red barnacle was brought up by a trawler from a depth of about 25 m., between the mouth of the Adour and Cap Breton. The specimen was identified by Dr. J. P. Harding of the British Museum (Natural History) as *Balanus tulipiformis* Ellis. So far as can be ascertained, *B. tulipiformis* has not previously been reported from any part of the Atlantic coast of Europe. Its distribution is given by Darwin[1] as Sicily, Malta, Malaga (associated with *B. perforatus*) and Madeira. Gruvel[2] gives the same distribution. Nilsson-Cantell[3] adds one further habitat, Wasin (West Africa).

Further, the specimen, with a basal diameter of 50 mm., would appear to be the largest of the species so far recorded from any locality. Darwin gives the measurement of the largest specimen (from Malta) as 1·4 in. (about 35 mm.) in basal diameter, and adds that, usually, full-sized specimens are about ¾ in. (about 20 mm.) in basal diameter. Gruvel gives the basal diameter as 18 mm.

Since the discovery of this specimen, it has become apparent that the species is well established on the south-west coast of France.

There is a 'whistling' buoy outside the bay of Saint-Jean-de-Luz moored in 25 m. of water. Each year this buoy is taken up, usually in September, being immediately replaced by another. The buoy was examined for cirripeds in September 1956 and again in September 1957.

When the buoy was taken from the water in September 1956 there was a number of isolated *Balanus* scattered over the surface below the waterline. These included a score or more *B. tulipiformis*, some of which had a basal diameter of 35 mm. There was a much greater number of *B. perforatus* Bruguière, and there were a few of a third species, identified by Dr. Harding as *B. amphitrite* Darwin. In September 1957, 36 *B. tulipiformis* were counted on the buoy. They were concentrated on or near the junction of the tube with the floating part of the buoy, that is to say somewhat deeper in the water than the rounded part of the buoy on which they had mostly settled the year before. The basal diameters of the largest specimens were 40 mm. (2), 38 mm. (3), 37 mm. (3). These sizes were attained in a single year, the buoy having been in the water from September 8, 1956, until September 18, 1957. As in the previous year there was a far larger number of *B. perforatus*, but on this occasion only one *B. amphitrite* (juv.) was observed. There was also a quantity of *Lepas anatifera* L. This species had not been seen in the previous year.

The buoy is situated at least 25 km. from the area from which the first example of *B. tulipiformis* was obtained. From more or less that same area and depth—25 m. or more—the same trawler, in July 1957, brought up a very old anchor on which were fixed a number of *B. tulipiformis* of various sizes. On the anchor was found the outer shell of what appears to have been a *B. tulipiformis* of great size, with a basal diameter of more than 75 mm. Young specimens of this species have also been found on shells of *Ostrea rugosa* Gmelin taken from crayfish traps set in 30 m. of water, or deeper, off Saint-Jean-de-Luz.

The presence of *B. amphitrite* on the buoy in 1956 is worthy of note. In a recent study of the cirripeds on the north coast of Spain, E. Fischer-Piette and M. Prenant[4] have noted the presence of *B. amphitrite* in certain ports and estuaries and its absence in others. This is explained as due to the fact that, to establish itself, this species requires a certain amount of turbidity in the water and is not to be found where the water is very clear. In an earlier work on the distribution of the principal intertidal species on the north coast of Spain, Fischer-Piette[5] remarks that in the situations known to him he has found this species living only in ports, estuaries and lagoons, and never on the open coast. In a letter to me he has stated that, except on the hulls of ships, he has only seen the species "dans des milieux souillés ou confinés".

It is probable that, in the case of the *B. amphitrite* on the buoy, the condition of turbidity of the water at the time of settlement may have been satisfied. Although more than a kilometre from the nearest land, the buoy is in direct line with the entrance of the harbour of Saint-Jean-de-Luz in the estuary of the River Nivelle. After heavy rain, an area of turbidity can be seen to extend up to and beyond the buoy, and sometimes to remain visible for several days. One cannot, therefore, exclude the possibility that, at the time of settlement of the larvæ of *B. amphitrite*, there may have been sufficient turbidity in the water around the buoy to permit of their establishment. On the other hand, the buoy is well out in the open sea, 1,200 m. from the nearest land. So there is no question here of a confined space. As noted above, only one young specimen of *B. amphitrite* was found on the buoy in 1957.

My sincere thanks are due to Dr. J. P. Harding for his identifications and for his kind advice in the preparation of this communication. I also wish to acknowledge the assistance received from Prof. E. Fischer-Piette and Monsieur M. Prenant.

B. S. Kisch

Saint-Jean-de-Luz,
Basses-Pyrénées,
France.

[1] Darwin, C., "Cirripedia", 204 (1854).
[2] Gruvel, A., "Monographie des Cirrhipedes", 216 (1905).
[3] Nilsson-Cantell, C. A., *Zool. Bidr. Uppsala*, **7**, 308 (1921).
[4] Fischer-Piette, E., and Prenant, M., *Bull. Centre Etudes et Recherches Scientifiques*, Biarritz, **1**, 7 (1956).
[5] Fischer-Piette, E., *Ann. Inst. Océanogr. Monaco*, N.S., **31**, 88 (1955).

A Possible Ecologial Effect of Upwelling in a Submarine Canyon

During July–November 1956, an exploratory ecological survey along the south-west edge of the La Jolla submarine canyon was conducted over a sandy bottom using self-contained underwater breathing apparatus[1] diving techniques (for a chart of the region see Shepard and Emery[2]), and the following preliminary information may be of general interest.

There are sharp changes in the dominant species of animals as one swims toward the north-west along the canyon axis between the 27- to 37-m. contours. In the shoreward regions (area 1) abundant populations of the sea-pen, *Stylatula elongata*, and the sea-star, *Astropecten californicus*, exist. Abruptly the community changes and is almost entirely *Astropecten* for about 50 m. (area 2). Continuing farther (area 3), brittle stars, *Ophiura lütkeni*, are found almost exclusively. On the broad, sandy continental shelf to the north *Ophiura* are not found until a depth of 47–50 m. is reached; *Astropecten* here occurs at 40–23 m. and *Stylatula* at 23–10 m. Boundaries between communities on the shelf appear to run parallel to the depth contours; at the canyon they run across the contours.

100–150 m. traverses were swum near the 30-m. contour along the edge of the canyon through the regions mentioned above. Centrally within these regions counts of animals were made in areas chosen at random by quadrats cast down blindly. Table 1 presents the marked differences which were found.

Table 1

Animal	Size of quadrat (m.²)	No. of individuals in each sample	Individuals (per m.²)
Area 1			
Astropecten	1	0, 0, 0, 0, 0, 0, 0, 2, 0, 3, 3	1
Stylatula	1	2, 1, 2, 1, 0, 0, 3, 5, 7, 6, 0	2
Ophiura	1	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0
Area 2			
Astropecten	1	1, 6, 4, 10, 2, 1	4
Stylatula	1	0, 0, 0, 0, 0, 0	0
Ophiura	1	0, 0, 0, 0, 0, 0	0
Area 3			
Astropecten	1	0, 0, 0, ¼, 0, 0, 0, 0, 0, 0	0
Stylatula	(three observed during a 50-m. swim)		0
Ophiura	0·05	4, 5, 4, 3, 2, 0, 3, 0, 5, 3, 0, 4	60

The areas on the canyon rim are not characterized by any large differences in substrate, depth and temperature. We have, however, while on the bottom in area 3, observed water currents coming from the direction of the canyon travelling up slopes as steep as 26°. Current velocities are variable both in magnitude and direction; but this is characteristic of near-shore currents in southern California. Velocity measurements, determined by timing the progress of a cloud of permanganate solution for 1 m., yielded vertical components as great as 45 cm./min. upwards. Studies of area 1 have as yet failed to give evidence of upwelling; this difference may be an important factor influencing the distributions discussed above. The commercially harvested kelp beds of *Macrocystis pyrifera* just south of area 3 may also be affected by the upwelling.

Tides, internal waves, and northerly currents could contribute to the upwelling; the biological data suggest that northerly currents may play an important part. Ophiuran populations occurring at 50 m. depth on the shelf and at 30 m. in the canyon allow the possibility of a water mass common to both places. Currents from the north at the 50 m. depth would run into the south wall of the canyon below area 3 and may upwell and flow across this region. Area 1 and possibly area 2, however, below 27 m. are protected from northerly currents by the shoal opposite wall of the canyon.

We are grateful for criticism and assistance to Prof. D. L. Fox and to Dr. E. W. Fager. The work was supported by the George A. Bisbee Donation and a Rockefeller Foundation donation for research in marine biology.

Raymond J. Ghelardi
Wheeler J. North

Division of Marine Biochemistry,
University of California,
Scripps Institution of Oceanography,
La Jolla, California.
Oct. 29.

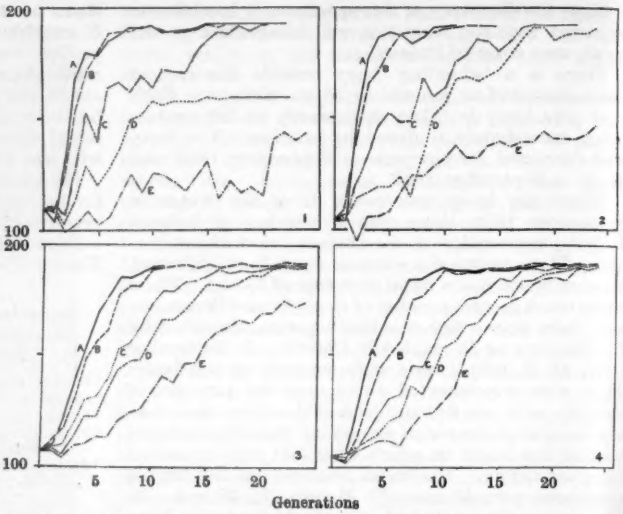
[1] North, W. J., *Yale Sci. Mag.*, **31** (1956).
[2] Shepard, F. P., and Emery, K. O., Geol. Soc. Amer. Spec. Paper No. 31 (1941).

Monte Carlo Analyses of Genetic Models

Automatic digital electronic computers, such as the SILLIAC, have several features which are of use in simulation of genetic systems. These are the ability to form sets of pseudo-random numbers[1], the ability to perform the operations of logical summation, equivalence, etc., and particularly the ability to perform a sequence of operations repeatedly at high speeds. A programme[2] has been written for the SILLIAC which simulates the action of selection on a population segregating for six loci. The programme has been run for complete dominance, equal effects at all loci, and no interactions between loci. The number of progeny was set at 100, and of parents at 50. Mating was at random. The initial population was set to contain the gametic types listed in binary notation in Table 1.

Table 1. Frequencies of Gametic Types in Parent Populations

Location						
a	*b*	*c*	*d*	*e*	*f*	Frequency
0	0	1	0	0	1	0·11111
0	0	1	0	1	0	,,
0	0	1	1	0	0	,,
0	1	0	0	0	1	,,
0	1	0	0	1	0	,,
0	1	0	1	0	0	,,
1	0	0	0	0	1	,,
1	0	0	0	1	0	,,
1	0	0	1	0	0	,,



Figs. 1–4. Rates of advance under selection calculated by the SILLIAC. In each figure there are five lines representing different degrees of recombination. Figs. 1–2 are at high intensity of selection, small population size. Figs. 3–4 are at low intensity of selection, large population size

The values of recombination between the six loci were set at the values given in Table 2.

Table 2. Recombination Values

Location						
a	*b*	*c*	*d*	*e*	*f*	
0·5	0·5	0·5	0·5	0·5		*A*
0·25	0·25	0·5	0·25	0·25		*B*
0·05	0·05	0·5	0·05	0·05		*C*
0·025	0·025	0·5	0·025	0·025		*D*
0·005	0·005	0·5	0·005	0·005		*E*

The programme therefore simulates conditions of recombination from complete independence (*A*), to tight linkage in two chromosomes, each containing three loci. Two runs were made at each set of recombination values, starting at different points in the set of pseudo-random numbers. The results are shown in Figs. 3 and 4.

As would be expected on general grounds, and from the analyses of Wright, Haldane and Fisher, there is a decrease in the rate of advance with increasing tightness of linkage. None of the runs showed any periods of no advance as were found by Mather[2] and used by him as the basis for the polygene concept. The programme was run again, changing the number of progeny to 40, of parents to 4 (that is, approximating the values of Mather's experiment). The results are shown in Figs. 1 and 2.

In these runs a more marked retardation of the rate of advance by increasing tightness of linkage was found. This is particularly the case in the runs at recombination values of 0·005, where distinct lags occurred in the advance under selection which are analogous to those found by Mather[2] in his second selection line which is illustrated in Fig. 5.

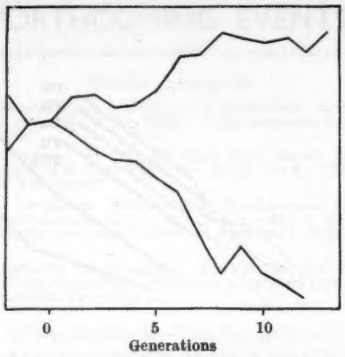


Fig. 5. Rates of advance under selection in *Drosophila*, from Mather, ref. 3

These runs indicate that any effects of linkage on the amount of variability present in a population will be slight at recombination values greater than 0·005 in populations of reasonable size. In small populations, the effects of linkage of this intensity are sufficiently great to produce qualitative changes in the curve of advance under selection, considerably reducing the efficiency of selection.

The above analyses are sufficiently encouraging to justify writing further programmes for Monte Carlo analyses of genetic systems. Three are being written covering (*a*) single loci, multiple populations with migration, (*b*) several loci, with variation of dominance, interactions, linkage, and number of chromosomes, and (*c*) several loci, no linkage, several phenotypes, environmental variation, non-random mating. Monte Carlo analyses can never be a substitute for complete mathematical simplifications. They can, however, be regarded as complementary to the present incomplete mathematical solutions, and provide an easily used tool for those geneticists, such as myself, who cannot otherwise add to the mathematical theory of natural selection.

A. S. Fraser

Animal Genetics Section,
Commonwealth Scientific and
Industrial Research Organization,
Zoology Department,
University of Sydney.

[1] Hoffman, J. G., Metropolis, N., and Gardiner, V., *J. Nat. Cancer Inst.*, **17**, 175 (1956).
[2] Fraser, A. S., *Aust. J. Biol. Sci.*, **10**, 4 (1957).
[3] Mather, K., *J. Genetics*, **41**, 159 (1941).

An Experimental Design for Three Factors at Three Levels

In an experiment with three factors at three levels each, the experimenter may be willing to sacrifice information on certain components of the two-factor interactions and to ignore the three-factor interactions completely except as an estimate of error[1]. A possibly useful experimental design for this purpose is detailed below.

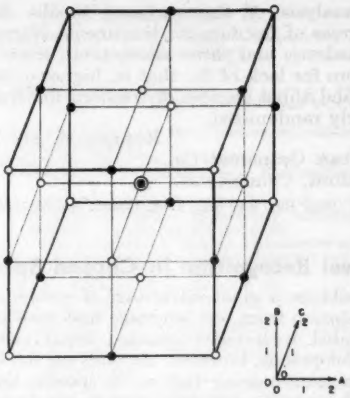


Fig. 1. The 3^3 factorial design and the cuboctahedron plus centre point. ○, ● + ⊙, 3^3 factorial; ●, cuboctahedron; ⊙, centre point

The experimental arrangement permits independent estimation of and tests of significance on both the 'linear' and 'quadratic' components of the main effects and on the 'linear × linear' components of the three two-factor interactions. As the basic experimental design requires only 16 observations, it can be used in 'mixed series' experiments with other factors at two or four levels each in partial replication of the whole (De Baun, R. M., unpublished). Moreover, quadruplicate replication of one experimental combination permits an estimate of true experimental error. The experimental design and appropriate orthogonal polynomials are detailed in Table 1. We may compare the power of estimation in this design to that of the 27 point 3^3 factorial design in single replication, by taking the variances of the several effects corrected by the ratio of the numbers of observations in each experiment. These variances relative to those of the 3^3 factorial design are: linear effects 1·333, quadratic effects 0·888 and linear times linear interaction effects 1·185. We thus gain information on the quadratic effects while sustaining an information loss on the linear effects and their interactions.

The experimental design cannot be further blocked independently of the previously cited effects. However, omission of a (111) point permits blocking into three blocks of 5 with the block contrasts partially confounded with the quadratic effects.

The basic experimental design can be seen to be a symmetrical fraction of the 3^3 factorial, as is shown in Fig. 1. Geometrically, the design may be viewed as a cuboctahedron in single replication with quadruplicate observations at the centre.

Table 1. Experimental Combinations and Orthogonal Polynomials

Observation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A level	0	2	0	2	1	1	1	1	0	0	2	2	1	1	1	1
B level	0	0	2	2	0	2	0	2	1	1	1	1	1	1	1	1
C level	1	1	1	1	0	0	2	2	0	2	0	2	1	1	1	1
A effect	−1	+1	−1	+1	0	0	0	0	−1	−1	+1	+1	0	0	0	0
A^2 effect	+1	+1	+1	+1	−1	−1	−1	−1	+1	+1	+1	+1	−1	−1	−1	−1
B effect	−1	−1	+1	+1	−1	+1	−1	+1	0	0	0	0	0	0	0	0
B^2 effect	+1	+1	+1	+1	+1	+1	+1	+1	−1	−1	−1	−1	−1	−1	−1	−1
AB effect	+1	−1	−1	+1	0	0	0	0	0	0	0	0	0	0	0	0

The analysis of the variance breaks down to nine degrees of freedom for treatments (three linear, three quadratic and three interaction), three degrees of freedom for lack of fit, that is, higher-order interactions and three degrees of freedom for true error, if properly randomized.

Robert M. De Baun

American Cyanamid Co.,
Stamford, Connecticut.

[1] Yates, F., Imp. Bur. Soil Sci., Tech. Comm. No. 35 (1937).

Vowel Recognition in Clipped Speech

It would be a great advantage if computers used for translation from one language into another could be provided with voice-operated input equipment. This development, however, depends on the isolation of information-bearing factors in speech, that is, a distinction among different sounds produced by a speaker and an identification of the same sound produced by different speakers.

In the course of work on speech-input devices for a translating machine, clipped speech was examined for the possible extraction of information-bearing factors. Since it is reported to be intelligible[1–4] while carrying information solely in the temporal pattern of zero-crossings, an apparatus was constructed to analyse the fine structure of the zero-crossings. The apparatus consisted of a magnetic tape player followed by amplifying and clipping circuits. The output was taken through a variable gate to a scaler so that the number of pulses in short intervals of time (of the order of 0·02 sec.) could be counted. The width of the gate was measured by passing generator pulses through it and counting them by means of the scaler. This arrangement, with routine precautions, allowed the number of pulses and time to be determined to an accuracy of about 1 per cent.

The first elementary sounds to be analysed were the vowels, because of their stability[5–8] and comparatively easy aural intelligibility. As a result of the experiment it was found that the plots of the number of pulses versus gate-width for the various vowels spoken by different persons were perfect straight lines. The slopes of these lines increased regularly from the vowel *i* (as in 'meet') to the vowel *a* (as in 'father'). Furthermore, the slopes were found to be reproducible within the limits of error of the apparatus. The vowels were thus recognizable singly as well as in combinations. Some of these results are shown in Figs. 1 and 2.

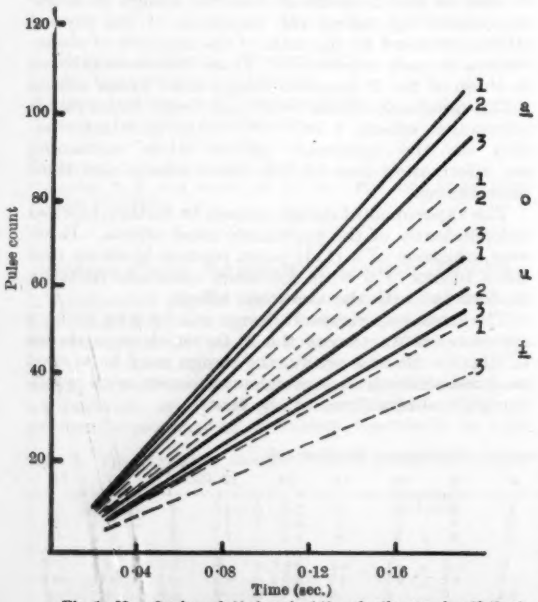


Fig. 1. No. of pulses plotted against time for the vowels *a* (father), o (tone), u (pool) and *i* (meet), spoken by three persons

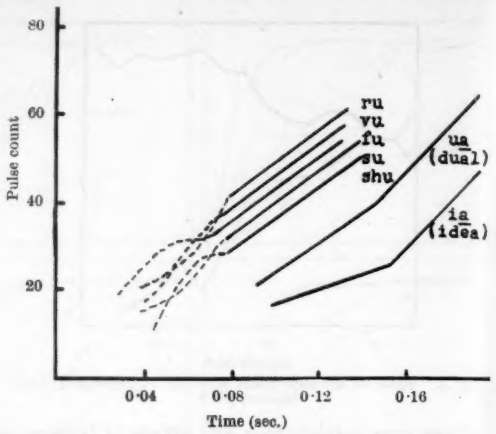


Fig. 2. Characteristic slopes of vowels in combination

	Counts per sec.			
	a	o	u	*i*
Voice 1	558	450	350	283
,, 2	533	417	317	—
,, 3	491	384	292	218

The constancy of pulse count per second for the various vowels throws some light on the particular feature by which clipped speech conveys information. Since vowels are made up of recurring trains of pulses (and yet they cannot be copied by pulses taken from a generator), it seems obvious that they carry information by: (1) the number of pulses in the interval of fundamental frequency and (2) the width-modulation of these pulses. It is interesting that the number of width-modulated pulses in the fundamental interval may be as small as two to three, as in the case of the vowel *i*.

Further work is being done on width-modulation within the fundamental period, and detailed results of the present study will appear elsewhere.

Rais Ahmed

Birkbeck College Computational Laboratory,
21 Torrington Square, London,
and
Department of Physics,
Aligarh University,
Aligarh, India.

[1] Licklider, J. C. R., *J. Acous. Soc. Amer.*, **20**, 42 (1948).
[2] Licklider, J. C. R., *J. Acous. Soc. Amer.*, **22**, 820 (1950).
[3] Vilbig, F., *J. Acous. Soc. Amer.*, **27**, A, 207 (1955).
[4] Sakai, T., and Inoue, S., *J. Inst. Elect. Com. Eng. Japan*, **39**, 404 (1956).
[5] Black, J. W., *Quart. J. Sp.*, **25**, 52 (1939).
[6] Siegenthaler, B. M., *Quart. J. Sp.*, **36**, 202 (1950).
[7] Ladefoged, P., and Broadbent, D. E., *J. Acous. Soc. Amer.*, **29**, 98 (1957).
[8] Flanagan, J. L., *J. Acous. Soc. Amer.*, **29**, 533 (1957).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 20

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. W. Birch: "The Economic Geography of the Isle of Man".

BRITISH COMPUTER SOCIETY (at York Hall, Caxton Hall, Westminster, London, S.W.1), at 6.15 p.m.—Dr. N. Levin: "The Physical Principles of Xerography".

INSTITUTE OF METAL FINISHING (at Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. A. McL. Aitken: "Some Properties and Applications of Chemically Reduced Nickel Coatings".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at Enfield Technical College, Queensway, Ponders End), at 7.30 p.m.—Dr. S. F. Birch: "Petroleum Chemicals".

Monday, January 20—Tuesday, January 21

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (in collaboration with the INDUSTRIAL PEST CONTROL ASSOCIATION, at 14 Belgrave Square, London, S.W.1), at 10 a.m. daily—Symposium on "Pests of Stored Products".

Tuesday, January 21

BRITISH NUCLEAR ENERGY CONFERENCE (at The Hoare Memorial Hall, Church House, Westminster, London, S.W.1), at 9.30 a.m.—Symposium on "Nuclear Energy".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. F. Greinig, Mr. R. W. Horseman and Mr. A. N. Kinkead: "The Design and Construction of the Foundations and Pressure Shell of the 8 ft. by 8 ft. High-Speed Wind Tunnel of the R.A.E., Bedford".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. G. F. Tagg: Informal lecture on "The Effect of Modern Industrial Requirements on Electrical Instrument Design".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. P. J. Duncton and Mr. T. F. R. George: "Environments and Environmental Testing".

Wednesday, January 22

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. C. H. Holland: "The Ludlovian and Downtonian Rocks of the Knighton District, Radnorshire"; Mr. F. M. Broadhurst: "A New Species of *Anthraconaia*, and a Study of Paleocecology in the Coal Measures of the Oldham Area, Lancashire".

ROYAL STATISTICAL SOCIETY (at the London School of Economics, Houghton Street, London, W.C.2), at 5.15 p.m.—Mr. G. S. Watson: "On Chi-Square Goodness-of-Fit Tests for Continuous Distributions".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. G. C. L. Bertram: "Eugenics in the Age of Crowding".*

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Dr. D. W. Gillings and Mr. W. Lawson: "The Shatter Strength of Cokes from High-Volatile Coals: Use of Plastometer Measurements on Blends for Test-Oven Experiments".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. Esping: "Special Problems of Broadcasting in Sweden".

INSTITUTE OF PHYSICS, EDUCATION GROUP (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. B. C. Brookes: "Presenting Science in Physics Text Books".

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Measurement of Noise and Vibration".

BRITISH PSYCHOLOGICAL SOCIETY, MEDICAL SECTION (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—Mr. D. Russell Davis: "Clinical Problems and Experimental Researches" (Chairman's Address).

Thursday, January 23

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. E. Lester Smith: "The Biochemical Functions of Vitamin B_{12}".*

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. R. E. D. Bishop: "Applied Mechanics in Engineering"* (Inaugural Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. H. W. Turner, Mr. S. E. Hanson and Mr. S. G. Kemp: "The Function of Aluminium Complexes as Structure Modifers in Paints".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. L. H. Bedford: "Guidance and Control".

Friday, January 24

BRITISH GLACIOLOGICAL SOCIETY (at the Geography School, 341 Bristol Road, Birmingham), at 5.30 p.m.—Mr. J. W. Glen: "The Cambridge Austerdalsbre Expedition 1955–57".

Saturday, January 25

BIOCHEMICAL SOCIETY (at the Glaxo Laboratories, Greenford, Middlesex), at 11.15 a.m.— Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL OF THE INSTITUTE OF AGRICULTURE, Moulton—Chief Education Officer, County Education Offices, Northampton (January 25).

RESEARCH ASSISTANT (qualified biochemist with some research experience) to Sir Rodolph Peters—The Secretary, Institute of Animal Physiology, Babraham, Cambridge (January 25).

LABORATORY STEWARD (familiar with the maintenance and preparation of general equipment and materials for chemistry and physics)—The Registrar, North Oxfordshire Technical College and School of Art, 51 The Green, Banbury, Oxon (January 25).

LECTURER IN MATHEMATICS—The Secretary of University Court, The University, Glasgow (January 31).

LECTURER (preferably with special interests in high frequency techniques or in servomechanisms) IN ELECTRICAL ENGINEERING—The Registrar, The Manchester College of Science and Technology, Manchester 1 (January 31).

LECTURERS IN INORGANIC CHEMISTRY AND IN PHYSICAL CHEMISTRY—The Registrar, The Manchester College of Science and Technology, Manchester 1 (January 31).

SENIOR LECTURER IN ELECTRICAL ENGINEERING at Singapore Polytechnic—The Council for Overseas Colleges, 12 Lincoln's Inn Fields, London, W.C.2 (January 31).

SENIOR RESEARCH FELLOW (graduate in mining, physics, mathematics or engineering, with postgraduate experience, preferably in the field of applied mechanics) IN THE POSTGRADUATE SCHOOL OF MINING, to undertake a study of the mechanics of rock fracture in mining processes—The Registrar, The University, Sheffield (January 31).

ASSISTANT PHYSICIST (graduate) IN THE PHYSICS DEPARTMENT, Coventry Radiotherapy Centre—The Secretary, Group 20 H.M.C., Coventry and Warwickshire Hospital, Coventry (February 1).

LECTURER (Grade I or Grade II) IN THE DEPARTMENT OF AGRICULTURE, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 3).

LECTURER (with special qualifications in physical chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (February 8).

ANALYST (with B.Sc. degree, preferably with honours in organic chemistry or equivalent and an interest in biochemistry and animal nutrition) IN THE NUTRITION RESEARCH LABORATORY, Department of Agriculture, Glenfield, New South Wales, Australia—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (February 12).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (February 14).

READER IN GEOLOGY at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 14).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS, CHEMICAL TECHNOLOGY OR CHEMICAL ENGINEERING—The Secretary, The University, Edinburgh (February 15).

LECTURER IN ZOOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 15).

SENIOR LECTURER (with high academic qualifications and/or professional qualifications and some teaching experience) IN CHEMICAL ENGINEERING at Neath Technical College—The Director of Education, County Hall, Cardiff (February 17).

LECTURER OR ASSISTANT LECTURER (preferably with research interest in some aspect of taxonomy) IN BOTANY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 25).

BABCOCK AND WILCOX RESEARCH FELLOW IN NUCLEAR ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (February 28).

CHALLIS CHAIR OF PHILOSOPHY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (February 28).

COURTAULDS' FELLOWS (2) (with a good honours degree in physics, chemistry or chemical engineering) for research in textile chemistry—The Registrar, The Manchester College of Science and Technology, Manchester 1 (February 28).

LECTURER (graduate with an interest in electronics and preferably a knowledge of experimental stress analysis) IN THE DEPARTMENT OF TEXTILE INDUSTRIES—The Registrar, The Manchester College of Science and Technology, Manchester 1 (March 1).

LEVERHULME POSTGRADUATE FELLOWS (3), TWO IN THE FACULTY OF SCIENCE and ONE IN THE FACULTY OF ENGINEERING—The Registrar, The University, Liverpool (March 1).

RESEARCH FELLOW for independent research—The Registrar (Room 22, O.R.B.), The University, Reading (March 17).

ASSISTANT (Grade B) TO TEACH CHEMISTRY with some PHYSICS or MATHEMATICS—The Principal, North-West Kent College of Technology, Miskin Road, Dartford.

ELECTRONIC ENGINEER, for the construction of electronic apparatus with special application to biological material—The Secretary, Institute of Ophthalmology, Judd Street, London, W.C.1.

ELECTRONICS TECHNICAL ASSISTANT (capable of maintaining and servicing existing equipment and assisting with the design and production of new electronic apparatus) IN THE INTERDEPARTMENTAL WORKSHOP of the Royal Free Hospital School of Medicine—The Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

LECTURER, ASSISTANT PROFESSOR, POSTDOCTORATE FELLOW, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF PHYSICS—Head of the Department of Physics, University of British Columbia, Vancouver B.C., Canada.

MASTER TO TEACH MATHEMATICS throughout the School to University Scholarship standard—The Headmaster, The Perse School, Cambridge.

MATHEMATICIANS and PHYSICISTS (with a good honours degree in mathematics or physics and preferably experience in hydro-dynamics and modern computing techniques), for work on theoretical reactor physics and transport theory—The Recruitment Officer (1002Z/34), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

RESEARCH ASSISTANT IN THE COMPUTING MACHINE LABORATORY—The Registrar, The University, Manchester 13.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or natural sciences or equivalent qualification), to undertake research in the physical and mechanical properties of explosives and to apply the data to a study of problems arising in weapon design—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1659/34.

SENIOR and JUNIOR RESEARCH FELLOWS (with a first- or second-class honours degree in an appropriate subject and evidence of a very high standard of ability in research) at Government Scientific Establishments—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4798/58.

SENIOR LABORATORY TECHNICIAN (male), to be responsible for the Laboratories (Chemistry, Physics, Biology), other Laboratory Staff and equipment and stock—The Principal, North-West Kent College of Technology, Miskin Road, Dartford.

SENIOR LECTURER IN HIGH POLYMER TECHNOLOGY—The Principal, Welsh College of Advanced Technology, Cathay's Park, Cardiff.

SENIOR LECTURER (preferably with an active interest in research in some branch of applied mathematics) IN MATHEMATICS—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

VISITING LECTURER IN MATHEMATICS—Prof. A. D. Wallace, Tulane University, New Orleans, La., U.S.A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Aluminium Development Association. List of Publications. Pp. 32. (London: Aluminium Development Association, 1957.) [1810

Bulletin of the British Museum (Natural History). Entomology. Vol. 5, No. 7: Neuropters and Trichoptera collected by Mr. J. D. Bradley on Guadalcanal Island, 1953–54. By D. E. Kimmins. Pp. 287–308. 7*s*. Vol. 5, No. 8: Odonata collected by Mr. J. D. Bradley on Guadalcanal Island, 1953–54. By D. E. Kimmins. Pp. 309–320. 4*s*. Geology. Vol. 3, No. 2: Eocene Mollusca from Nigeria: a Revision. By Frank E. Eames. Pp. 23–70+plates 5–10. 25*s*. Vol. 5, No. 4: A Revision of the Lake Victoria *Haplochromis* Species (Pisces, Cichlidae). Part 2: *H. sauvagei* (Pfeffer), *H. prodromus* Trewavas, *H. granti* Blgr., and *H. zenognathus*, SP.N. By P. H. Greenwood. Pp. 76–97+plate 4. 8*s*. (London: British Museum (Natural History), 1957.) [1810

Agricultural Research Institute of Northern Ireland. Thirtieth Annual Report, 1956–1957. Pp. 40. (Hillsborough, Co. Down: Agricultural Research Institute, 1957.) [2110

Solvents, Plasticisers, and Technical Chemicals. Pp. 90. (Ilford: Howards of Ilford, Ltd., 1957.) [2110

Anti-Locust Bulletin 28: Factors Affecting the Rate of Sexual Maturation of the Desert Locust (*Schistocerca gregaria* Forskål) in the Laboratory. By Dr. Maud O. W. Richards. Pp. ii+26. (London: Anti-Locust Research Centre, 1957.) 3*s*. [2110

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 975, Vol. 250 (17 October 1957): Statistical Properties of an Isotropic Random Surface. By M. S. Longuet-Higgins. Pp. 157–174. 6*s*. No. 976, Vol. 250 (17 October 1957): The Statistical Thermodynamics of Mixtures of Lennard-Jones Molecules. 1: Random Mixtures. By W. B. Brown. Pp. 175–246. 22*s*. 6*d*. No. 977, Vol. 250 (17 October 1957): The Aerodynamic Forces on an Aerofoil in Non-Uniform Unsteady Motion in a Closed Tunnel. By S. Rosenblat. Pp. 247–278. 10*s*. (London: Royal Society, 1957.) [2110

The Hydrogen Bomb. Pp. 32. (London: H.M. Stationery Office, 1957.) 9*d*. net. [2210

Federation of British Industries. Report of the Second National Conference between Industry and the Technical Colleges, 15 May, 1956. Pp. vi+71. (London: Federation of British Industries, 1957.) 5*s*. [2310

The Non-Destructive Testing of Engineering Materials (With Particular Reference to their Internal Structure and Properties). Second edition. Pp. 24. (Southall, Mddx.: A. E. Cawkell, 1957.) [2310

Department of Scientific and Industrial Research. Problems of Progress in Industry, No. 1: Men, Steel and Technical Change. By the Industrial Research Section, Department of Social Science, University of Liverpool. Pp. 36. (London: H.M. Stationery Office, 1957.) 2*s*. net. [2410

Other Countries

Food and Agriculture Organization of the United Nations. FAO Forestry Development Paper No. 8: Tree Planting Practices in Tropical Africa. By M. S. Parry. Pp. xii+302. 15*s*.; 3 dollars. FAO Forestry Development Paper No. 11: Tree Planting Practices in Tropical Asia. Prepared by Charles Letourneux. Pp. vii+172. 10*s*.; 2 dollars. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1957.) [1810

Current Contents of Pharmaceutical Publications. (Weekly Survey of Chemical, Pharmacological and Clinical Publications.) Pp. 56. (Philadelphia, Pa.: Eugene Garfield Associates, 1957.) [1810

Durban Museum Novitates. Vol. 5, Part 2: Notes on African Bats. 1: Some Systematic and Anatomical Notes on the African Bats of the Genus *Otomops* Thomas. By David L. Harrison. Pp. 17–26 (2 plates). (Durban: Durban Museum, 1957.) 2*s*. 6*d*. net. [2110

New Zealand. Thirty-first Annual Report of the Department of Scientific and Industrial Research, 1957. Pp. 84. (Wellington: Government Printer, 1957.) [2310

Berichte des Deutschen Wetterdienstes. Nr. 38 (Band 5): Symposium über Numerische Wettervorhersage in Frankfurt a. M. vom 23. bis 28. Mai 1956. Pp. 97. (Bad Kissingen: Deutschen Wetterdienstes, 1957.) [2310

Tanganyika: Department of Geological Survey. Geological Survey Maps Nos. 102L, 1021, Lo79, 1093. (Dodoma: Department of Geological Survey, 1957.) [2910

F.A.O. Picture Sheet No. 8: Frontiers Need Not Be Barriers. Pp. 2. (Rome: Food and Agriculture Organization of the United Nations, 1957.) [2910

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-verbaux des Réunions. Vol. 143, Part 1: On the Herring of the Southern North Sea. (Contributions to Special Herring Meetings, 1956.) Pp. 42. (Copenhague: Andr. Fred. Høst et Fils, 1957.) 10 Kr. [2910

National Vitamin Foundation, Inc. Symposium on Nutrition and Behavior: Proceedings of a Symposium held at the University of Minnesota, School of Public Health, Laboratory of Physiological Hygiene, Minneapolis, Minnesota, April 27, 1956. Pp. iv+124. (Nutrition Symposium Series, No. 14.) (New York, N.Y.: National Vitamin Foundation, Inc., 1957.) 2.50 dollars. [2910

Catholic University of America. Biological Studies, No. 41: Recovery of Texas-1 Coxsackie Virus from the Blood of a Wild Rabbit. By John R. O'Connor, M.S. Pp. v+17. (Washington, D.C.: Catholic University of America, 1957.) 25 cents. [2910

Bulletin of the American Museum of Natural History. Vol. 113, Article 3: On the Anatomy and Relationships of *Fregilupus varius*, an Extinct Starling from the Mascarene Islands. By Andrew J. Berger. Pp. 225–272. 1 dollar. Vol. 113, Article 4: The Fishes of Labrador. By Richard H. Backus. Pp. 273–338+plates 4 and 5. 2 dollars. (New York: American Museum of Natural History, 1957.) [2910

Records of the Australian Museum, Sydney. Vol. 24, No. 2 (23 November, 1956): A Revision of the New South Wales Leptonidae (Mollusca: Pelecypoda). By Charles F. Laseron. Pp. 7–22. Vol. 24, No. 3 (23 November, 1956): Fishes from Inland New Guinea. By Gilbert P. Whitley. Pp. 23–30+plate 2. Vol. 24, No. 4 (23 November, 1956): Additional Remarks on Australian Gyrinidae. By Georg Ochs. Pp. 31–36. Vol. 24, No. 5 (23 November, 1956): Rock Engravings of the Sydney-Hawkesbury District. Part 1: Flat Rocks Ridge—a Daruk Ceremonial Ground. By Frederick D. McCarthy. Pp. 37–58+plates 3–6. Vol. 24, No. 6 (23 November, 1956): A New Species of Ascidian (Genus *Culeolus* Herdman, Family *Pyridae*, from the West Coast of Tasmania. By Patricia Kott. Pp. 59–60. Title-Page and Index to Vol. 22. Pp. 13. Title-Page and Index to Vol. 23. Pp. 8. (Sydney: The Australian Museum, 1956.) [2910

South African Council for Scientific and Industrial Research: Library and Information Division. Register of Current Scientific Research at South African Universities, 1956. Pp. vii+251. (Pretoria: South African Council for Scientific and Industrial Research, 1956.) [2910

Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België. Klasse der Wetenschappen. 3rd International Conference on Biochemical Problems of Lipids, 26th to 28th July, 1956—The Blood Lipids and the Clearing Factor. Pp. 418. (Brussel: Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België, 1957.) [2910

Federation of Nigeria. Annual Report on the Department of Agricultural Research for the year 1955–56. Pp. 24. (Lagos: Federal Government Printer, 1957.) 9*d*. net. [2910

Bengal Immunity Research Institute. Five-year Report (Jan. 1951–Dec. 1955). Pp. viii+35+14 plates. (Calcutta: Bengal Immunity Research Institute, 1957.) [2910

South Australia. The Institute of Medical and Veterinary Science—Eighteenth Annual Report of the Council, July, 1955–June, 1956. Pp. 109. (Adelaide: Institute of Medical and Veterinary Science, 1957.) [2910

B.A.N.Z. Antarctic Research Expedition, 1929–1941. Reports—Series B (Zoology and Botany). Vol. 3: Copepods from Antarctic and Sub-Antarctic Plankton Samples. By W. Vervoort. Pp. 160+138 figures. 80*s*. Vol. 6, Part 3: Free-Living Nematodes. Section: Enoploidea from Antarctic Stations. By Patricia M. Mawson. Pp. 37–74. 12*s*. Vol. 6, Part 4: Cestodes from Mammals. By Betty W. McEwin. Pp. 75–90. 10*s*. Vol. 6, Part 5: Acanthocephala. By Stanley J. Edmonds. Pp. 91–98. 6*s*. Vol. 6, Part 6: Hirudinea. By J. Percy Moore. Pp. 99–106. 4*s*. (Adelaide: B.A.N.Z.A.R. Expedition Committee, 1956 and 1957. Issued through the Barr Smith Library, University of Adelaide.) [2910

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £7/15/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2.
Telephone Number: Holborn 4743

All rights reserved. Registered as a newspaper at the General Post Office

Only very occasionally does a new material appear that has a widespread potential throughout industry.

Here, though, is just such a product — a unique material that deserves your fullest understanding.

Refrasil

is the name given to a lightweight fibrous silica material, of very fine diameter, which is capable of withstanding continuously temperatures in the order of 1,000°C, or for short periods, even above. It has outstanding thermal insulating characteristics at elevated temperatures, as well as being an excellent high temperature electrical insulator. Like fused silica it has a high resistance to thermal shock and to chemical attack from acids.

It is available as batt, felted wool, cloth, tape, sleeving, bulk fibre, cord, and yarn.

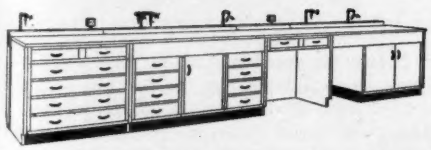
There are many other things well worth your knowing about Refrasil; we have incorporated them all in a brochure which we would like to send you.

REFRASIL

THE BRITISH REFRASIL COMPANY LTD
Stillington, Co. Durham Tel: Stillington 351

R7b

a **NEW** *range of*
LABORATORY METAL FURNITURE
AND PREFABRICATED SERVICE RACKS



The *flexibility*, *economy* and *general usefulness* of UNIT furniture are advantages which cannot be disregarded. We offer standard benches of modern design and construction, with removable units, in metal and wood; and standard service racks which will connect up to supplies (electricity, gas, water, steam, etc.) provided at any one point in the Laboratory. May we tell you more about them?

★ **New illustrated catalogue (P.2029) free on request.**

GRIFFIN & GEORGE LIMITED
Head Office: Ealing Road, Alperton, Wembley, Middlesex
Phone: PERivale 3344

BIRMINGHAM	Frederick Street, 1	*Central* 2552
MANCHESTER	Cheetham Hill Road, 4	*Blackfriars* 6041
GLASGOW	Renfrew Street, C2	*Douglas* 0747
EDINBURGH	Johnston Terrace, 1	*Caledonian* 4868

BECK

LOW POWER BINOCULAR MICROSCOPES

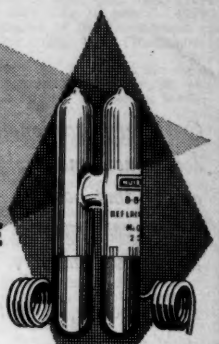
The many uses in industry and science for which this type of microscope is suited are fully explained in booklet, post free on application.

•

R. & J. BECK Ltd.
69/71 MORTIMER STREET
LONDON, W.1

MUIRHEAD

D-845 REFERENCE CELLS



SPECIFICATION 312

E.M.F.	1·0193 volts absolute. Subject to manufacturing tolerance not exceeding 0·0004V (unmounted); and 0·0002V (mounted)
Temperature co-efficient	Does not exceed 5μV/°C over the range 10° - 40°C
Internal resistance at 25°C	Average 800 ohms maximum 1200 ohms
Temperature hysteresis	Negligible over normal operating range of temperature

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND
Phone: Beckenham *Grams & Cables:* MUIRHEAD BECKENHAM

MUFFLE FURNACES

FOR GENERAL PURPOSES
MAXIMUM TEMPERATURE 1000°C. ENTIRELY SELF-CONTAINED

- Modern, clean appearance with built-in control equipment.
- Cases made of asbestolite panels which ensure maximum resistance to corrosion and present smooth external surfaces.
- High quality wire-wound elements, external to the muffles and hence protected from fumes and gases arising inside the furnace during operation.
- Uniform temperature and low power consumption.
- All furnaces protected by a temperature fuse.
- Removable panel permits easy access for renewal of heating elements in the event of failure.

Send for catalogue No. 558A giving full details of our complete range of laboratory furnaces.

GALLENKAMP

A. GALLENKAMP & CO. LTD., SUN ST., LONDON, E.C.2
Tel: Bishopsgate 0651 Grams: Gallenkamp, Stock, London

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and ST. MARTIN'S PRESS, INC., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, January 18, 1958.